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The Operating and The Consulting Engineer

The operating and the consulting engineer have an interest in common. Both working to produce the most successful operation of power plants. Co-operating they can accomplish what is impossible for either if working single-handed. The more the operating engineer realizes the value of the consulting engineer's advice and the consulting engineer the value of the operating engineer's experience, the better it is for both of them.

Some operating engineers believe the consulting engineer to be an "undesirable." It requires no argument to show that this attitude is absurd. The misconception exists because in the early days of power-plant practice a consulting engineer was not required so often to check up the operating conditions. The competition in the field of power generation was not so intense and the operating engineer's position was more secure. Not so today.

With efficiency systems invading all establishments to effect more economical operation, the plant must show that it is worth operating. If it is not, it must give way to cheaper sources of power. The engineer's object then is to make his plant the cheapest source of power, in fact, his bread and butter depend upon it.

No one can help him more in doing this than the consulting engineer. This kind of work is his specialty.

When central-station agents propose to the plant owner the use of their service and the elimination of the isolated plant, the consulting engineer should make the test that shall decide whether central-station or isolated-plant service shall be used. The operating engineer should *insist* upon the calling in of a competent consulting engineer at such crucial times.

At other times as well the advice of a consulting engineer may prove of value. Even when everything is thought to be in the best condition it is worth while to be sure of it by having a test made occasionally by an outside expert.

This would not be an acknowledgment of incompetency on the part of the operating engineer, any more than an expert accountant's certification of a corporation's accounts reflects upon the accuracy of the office force.

If this practice should become prevalent in power plants, and it is likely to, it would be one of the greatest incentives for the engineer to keep his plant in the best possible condition. It would mean a higher recognition of him by his superior and betterment in every way.

Welcome the consulting engineer and **don't** despise his aid.

New Power Plant at Weber Wagon Works

By A. R. Maujer

SYNOPSIS—Description of a plant containing two 750-kw. bleeder-type turbines and water-tube boilers with dutch-oven furnaces, using a combination of wood refuse and coal as fuel. Circulating water from the condenser is cooled by a spray-nozzle cooling system.

There comes a time in the history of almost every manufacturing works when the increase in output requires either a substantial extension of the existing power plant or the erection of a new plant. Usually when such factors as age, condition and efficiency of the existing equipment

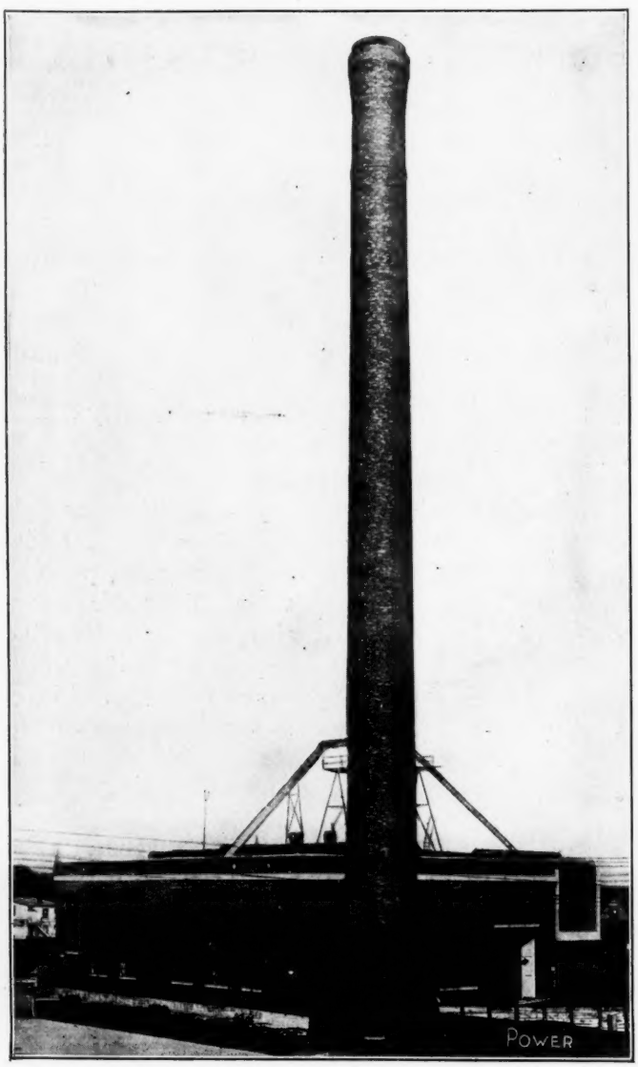

Fig. 1. Power Plant of the Weber Wagon Works

are taken into consideration and when attention is given to the prospects of still further expansion, a new plant is decided upon, which is laid out with the changed needs of the works as the influencing factor.

Such was the situation existing at, and the policy adopted by, the Weber wagon works of the International Harvester Co., located at Eighty-first and Wallace Sts., Chicago, Ill.

Original Plant

The old power plant contained four 250-hp. water-tube boilers, fired with a mixture of wood refuse and coal. The original power unit was a 24x48-in., 750-hp. Corliss engine, at 82 r.p.m. This unit drove, by a rope drive, a main shaft from which numerous countershafts distributed the power to the various machines throughout the works. Later, a 19x18-in., four-valve automatic engine was installed for driving a 200-kw., three-phase, 60-cycle current, 480-volt generator for lighting and some power service. During a few years just prior to the erection of the new plant, about 30,000 kw.-hr. per month were purchased from the central station.

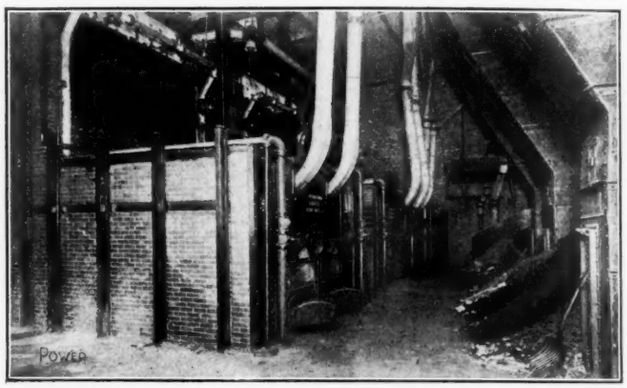

Fig. 2. Boiler Equipment

Exhaust steam from the engines was used to heat the various buildings and some drying kilns by means of a combination direct- and indirect-radiation system.

With the installation of the new power plant the system of transmission was changed from shaft and belt or rope to electric drive, some 80 motors, of sizes from 1 to 50 hp., distributed throughout the plant, being used for individual or group drive, according to the requirements in each case.

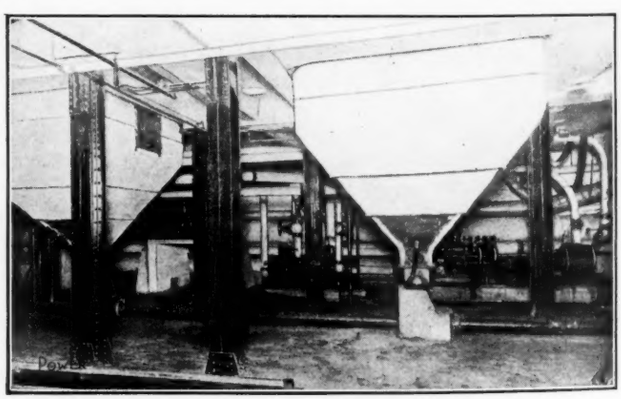

Fig. 3. Ashpits, Ash-Conveyor Pipe and Feed Pump

New Power Plant

The new power plant is in a separate building across

Wallace St., some 50 ft. from the main works. It was decided to so house the power equipment because the fire hazard is considerably reduced thereby, an important consideration in a plant where much wood and other inflammable material is used. Then, too, it was important that the work of the plant be not interrupted during the process of changing and the separate plant was the best solution of this problem.

In Fig. 1 is shown the power house, a one-story-and-basement building, which occupies an irregular plot. The frame is of steel and the walls, roof and floors are of concrete, the outside walls being finished with a veneer of hard-burned red brick and inside walls with a wainscot of white enamel-faced brick, red brick above as high as the crane rail and common brick painted white above that. Windows, 8x25 ft. in size, are set as close together as possible, thus providing for maximum light and ventilation.

All of the equipment has been selected with an eye to economy and service as the sole objects in view, first cost being the last influencing factor. No opportunity has been neglected in arranging the apparatus for accessibility, on the principle that anything which is difficult to "get at" is almost certain to be neglected. The personal safety of the operators has been increased wherever possible by the employment of such devices as nonreturn valves, oil switches, etc., and their physical comfort has been provided for in the shape of locker rooms for clothing and sanitary lavatories and shower baths.

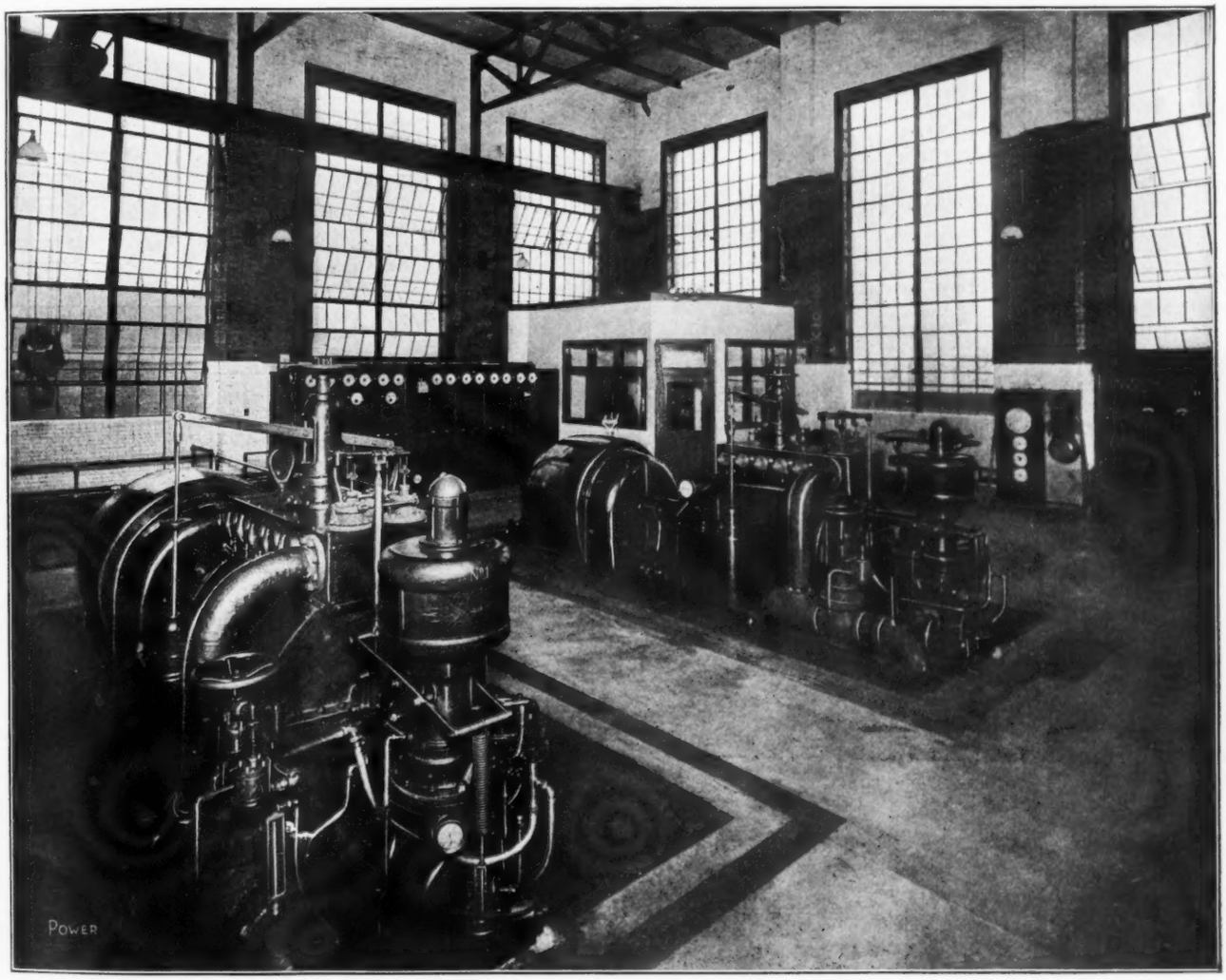

FIG. 4. TURBINES OF THE WEBER WAGON WORKS PLANT.

BOILER EQUIPMENT

Arrangements have been made for burning refuse in the form of shavings and sawdust from the works, with whatever additional coal is required to make up the needed amount of fuel. At present there are three 410-hp. water-tube boilers. The stack is large enough, however, to provide draft for at least five additional boilers of the same capacity. Each boiler contains 203 four-inch tubes 18 ft. long and two 34-in. by 18-ft. steam drums, giving an effective heating surface of 4098 sq.ft. The boilers are designed for a working pressure of 200 lb., gage, but the working pressure is only 150 lb., gage. Each boiler is equipped with a superheater, located in the last pass, and is guaranteed to superheat 18,000 lb. of steam per hour 75 deg. F.

Dutch-oven furnaces are used, as shown in Fig. 2, with stationary herring-bone grates, 8 ft. by 9 ft. 6 in. in size, having 76 sq.ft. of surface, 40 per cent. air space. Shavings and sawdust are delivered to the boiler room by air blast through a sheet-iron duct which discharges into two

"cyclone" collectors located on the roof. From these the fuel feeds by gravity either directly into the furnaces or into sheet-iron bins, along one side of the boiler room, in which any excess is stored.

When this excess is required in the furnaces it is discharged through hoppers in the bottom of the bins into a return air duct which again delivers the sawdust to the collectors on the roof from which it is discharged to the furnaces through feed spouts. Motor-driven agitators, located in the discharge hoppers of the storage bins, are operated when feeding into the return air duct so that the sawdust cannot become packed and choke up the discharge openings or the pipes.

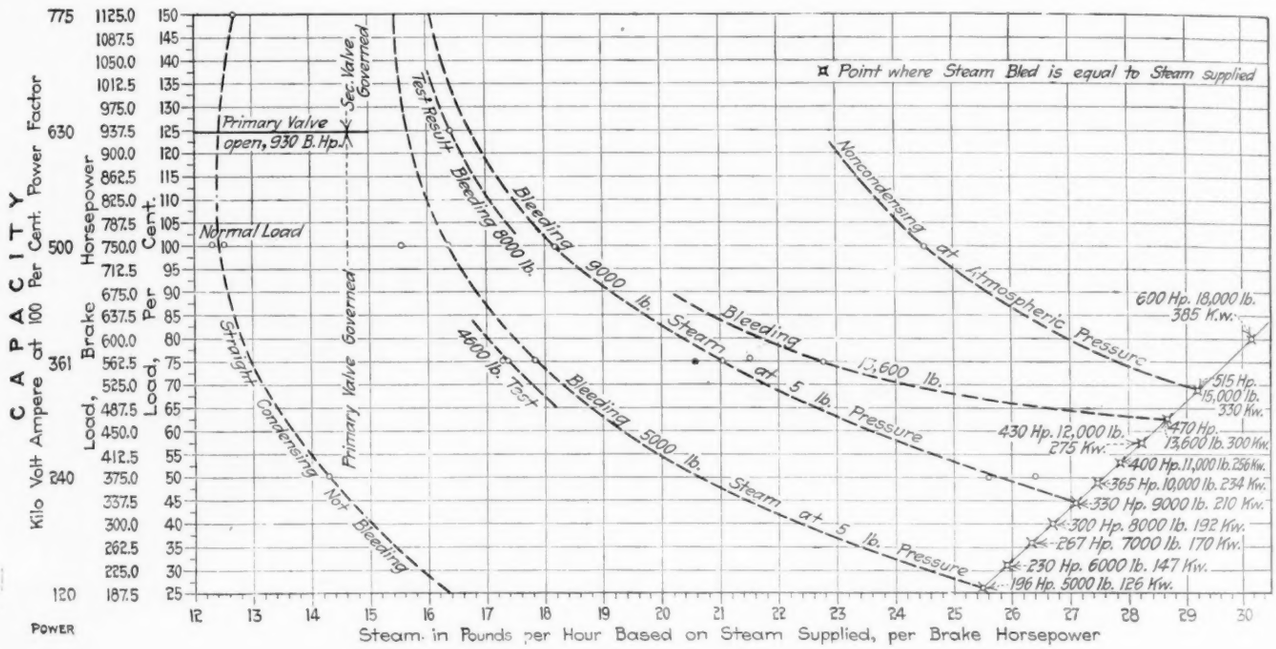
CAPACITY
Kilo Volt Ampere at 100 Per Cent. Power Factor
Brake Horsepower
Load, Per Cent.
Power
Steam in Pounds per Hour Based on Steam Supplied, per Brake Horsepower
Point where Steam Bled is equal to Steam supplied
Primary Valve open, 930 B.Hp.
Sec. Valve Governed
Primary Valve Governed
Normal Load
Test Result
Bleeding 8000 lb.
Bleeding 9000 lb. Steam at 5 lb. Pressure
Bleeding 13,600 lb.
Bleeding 5000 lb. Steam at 5 lb. Pressure
4000 lb. Test
Straight Condensing Not Bleeding
Noncondensing at Atmospheric Pressure
600 Hp. 18,000 lb. 385 Kw.
515 Hp. 15,000 lb. 330 Kw.
470 Hp. 13,600 lb. 300 Kw.
430 Hp. 12,000 lb. 275 Kw.
400 Hp. 11,000 lb. 256 Kw.
365 Hp. 10,000 lb. 234 Kw.
330 Hp. 9000 lb. 210 Kw.
300 Hp. 8000 lb. 192 Kw.
267 Hp. 7000 lb. 170 Kw.
230 Hp. 6000 lb. 147 Kw.
196 Hp. 5000 lb. 126 Kw.

FIG. 5. TURBINE TESTS

With this arrangement the firemen are never required to fire the sawdust by hand. Under present operating conditions the sawdust constitutes about 60 per cent. of the fuel, the balance being Illinois bituminous coal, hand fired. No special provisions have been made for handling the coal because the quantity used is comparatively small. The coal is delivered from cars on the siding alongside the boiler room into a bin adjacent to the plant from which it is wheeled in barrows to the furnaces.

Ashes fall into rectangular steel pits which discharge through hoppers to the conveyor pipe of a vacuum ash-handling system located on the basement floor, Fig. 3. The ashes are delivered to a storage bin over the railroad siding, from which they fall by gravity into a car.

The chimney is of tile and reinforced-concrete construction, 200 ft. high, and with an inside top diameter of 8 ft. 6 in. The breeching is of sheet iron, covered with 1½ in. of asbestos.

TURBO-GENERATORS

At present the main generating equipment consists of two horizontal automatic bleeder-type turbines, driving 750-kw. maximum rated dynamos of the revolving-field type, Fig. 4. The rating is based on 80 per cent. power factor and a temperature rise of 50 deg. C., under continuous operation. These units run at 3600 r.p.m. and generate three-phase, 60-cycle current at 480 volts. A 100-kw. noncondensing turbine unit, the exhaust from which is used in the heating system, is employed for service at night, on holidays and at other times when the load is light. There are two 25-kw. exciters, one driven by a motor, the other by a noncondensing turbine.

A most interesting feature about the main units is the bleeder arrangement and the operating economy secured. The turbines are designed on the combined impulse and reaction principle, having one impulse wheel acted upon by the velocity of the steam and an upper and lower reaction wheel acted upon by expansion. A bleeder tap is made at the point of connection between the upper and lower reaction stages and a certain amount of steam may be drawn off to supply the heating system throughout the works. The balance of the steam passes through the final stage and on into the condenser. The connection between the bleeder and the final stage is controlled by an automatic valve, which is set by weights to maintain a definite pressure on the heating system, usually 5 lb., gage. The bleeder valve may also be regulated by hand.

By this arrangement the steam required for heating is first made to do work in the turbine and all but the exact quantity of steam so required is fully expanded in the turbine. In addition to being operated in this manner the turbines may be operated noncondensing, passing all the steam to the heating system, or they may be operated condensing, when all the steam goes direct to the condenser and none to the heating coils.

Under normal operation in the summer each turbine furnishes about 5500 lb. of steam through the bleeders for use in wood-drying kilns; in the winter an additional 10,000 lb. of steam is bled from each for the heating system. Hence, the machines were designed with the low-pressure stage arranged to pass 5500 lb. of steam per hour less than the high-pressure, and they are most efficient when operating under this condition.

Each turbine is provided with a primary and a secondary inlet valve of the balanced-poppet type, both controlled

by the governor. Under operating conditions the primary valve is opened first and when wide open passes a quantity of steam at 150 lb. pressure, just sufficient for the normal load of the unit. The secondary valve then comes into action and when wide open will supply steam for the designed maximum overload requirements at maximum overload speed. Should the load increase still further the result would be a drop in speed and frequency. Each turbine is further provided with an overspeed device, which will automatically close the throttle when the speed reaches a predetermined rate. This device is set to operate when the speed reaches 20 per cent. above normal.

As customary, the turbines were tested at the shops of

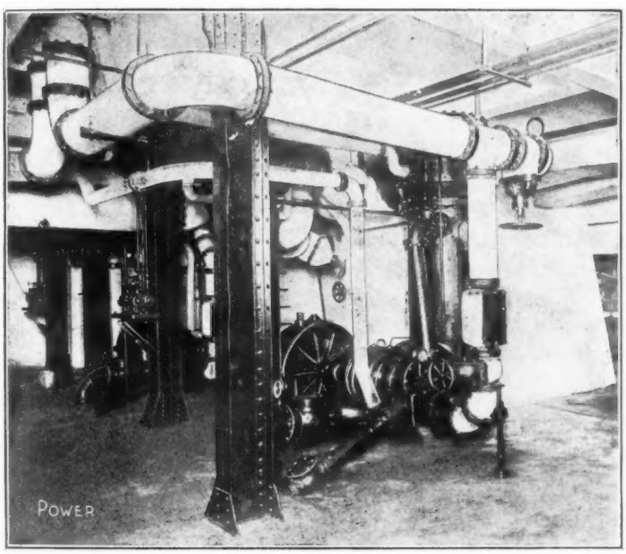

FIG. 6. CONDENSERS AND CONDENSER PUMPS

the builder in the presence of a representative of the purchaser; the results obtained are presented graphically in Fig. 5.

The condensers, Fig. 6, are located in the basement directly below the turbines. The circulating water and the air pump for each condenser are mounted on one shaft and driven by a single-stage noncondensing turbine.

The condensing water is taken from a 600,000-gal. concrete basin, located just south of the plant, which was installed primarily as a storage reservoir for a fire-fighting equipment. The return water from the condensers is cooled by passing it through spray nozzles, Fig. 7, located above the basin. The capacity of the circulating-water system is sufficient for a 2250-kw. equipment and it is capable of cooling the water from 100 to 70 deg. F. under the average atmospheric conditions at the plant. The piping is so arranged that if needed a motor-driven centrifugal pump can be installed to draw water from the basin and pass it through the spray nozzles at a more rapid rate than the circulating pumps provide.

PIPING

All the auxiliaries, including the boiler-feed pumps, and the piping are located in the basement. The steam is delivered from the boilers in 7-in. leads, controlled by automatic nonreturn valves, to a 10-in. main header, hung on brackets on the building columns in the basement directly beneath the wall between the boiler and engine rooms. From this header a 5-in. lead supplies steam to each main unit and to its condenser-auxiliary turbine through a 2-in. branch. The 100-kw. unit may be fed from either the main or the auxiliary header.

An 8-in. auxiliary header, lying close to and parallel with the main header, serves the fire pumps, the 100-kw. unit and the boiler-feed pumps only. With this arrangement it is possible, in case of fire, to shut down everything except these pieces of apparatus. The lead from the main header to the 100-kw. unit is 5 in. in diameter, reducing to 4 in. beyond a 2½-in. branch which supplies the exciter turbine. The lead from the auxiliary header is 4 in. in diameter and connects with the main-header lead half way between the headers and the turbine.

AUXILIARIES

There are two duplex Underwriter fire pumps, each 18 and 10 by 12 in. in size and capable of delivering 1000 gal. per min. at a pressure of 100 lb. per sq.in. when running at 70 r.p.m. These are located in the basement beneath an open hatch in the engine-room floor so as to be in sight of the engineer on watch.

One of the two boiler-feed pumps is a two-stage centrifugal, driven by a steam turbine at 3600 r.p.m. The suction, connecting with the feed-water heater, and the discharge pipes are both 3 in. in diameter. The other feed pump is a 10 and 6 by 12-in., pot-valve, outside end-packed duplex pump, bronze-lined throughout. The capacity of each of these pumps is 21,000 lb. of water per hour against a pressure of 150 lb. gage. The feed piping is in duplicate throughout. The steam piping for these pumps is also in duplicate, one pipe connecting with the main header and the other with the auxiliary header for the reason given above. All high-pressure steam and water piping is extra heavy with screwed flanges.

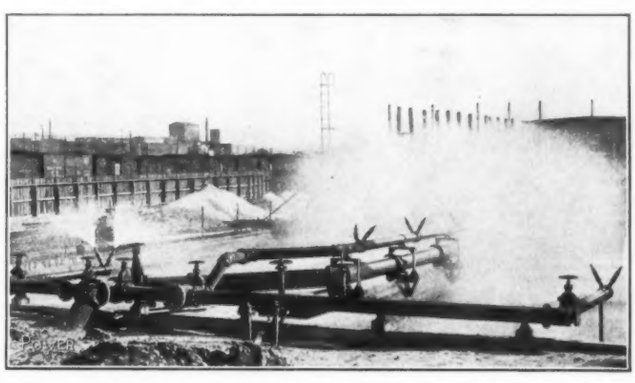

FIG. 7. COOLING BASIN

Feed-water is measured with a venturi meter having two tubes, one 3 in. in size for day operation, the other 1⅝ in. for night use. The indicating and recording part of the meter is located in the engine room conveniently near the engineer's office.

An open type of feed-water heater, rated at 2400 hp., receives the returns from the heating system and the drips from the various steam lines through a 6-in. line. A secondary source of water supply is the discharge from the condenser air pumps and a third source is the city-water mains. A 10 and 14 by 20-in. simplex pump is used for the vacuum of the heating system.

With the exceptions previously mentioned all auxiliary apparatus is supplied with steam from the mair header

MECHANICAL EQUIPMENT OF THE POWER PLANT OF THE WEBER WAGON WORKS

No.	Equipment	Tpye	Purpose	Kw.	Volts	R.p.m.	Size	Press.	Hp.	Manufacturers
3	Boilers	Water tube	Steam gen.	...	...	....	.....	150	410	Edge Moor Iron Co.
3	Superheaters	Foster	Sup. steam	...	...	....	.....	...	...	Power Specialty Co.
2	Generators	Alt. current	Main units	750	480	3600	.....	...	...	Westinghouse Elec. & Mfg. Co.
1	Generator	Alt. current	Main unit	100	...	....	.....	...	...	
2	Generators	Direct current	Exciters	25	125	....	.....	...	...	
2	Turbines	Horizontal	Main units	750	...	3600	.....	...	...	
1	Turbine	Horizontal	Main unit	100	...	....	.....	...	...	Westinghouse Mfg. Co.
1	Turbine	Single stage	Exciter unit	25	...	....	.....	...	...	
3	Condensers	Leblanc	Turbines	...	...	....	.....	...	...	
2	Pumps	Knowles	Fire	...	...	70	18x10x12"	...	...	International Steam Pump Co.
1	Turbine	Single stage	Feed pump	...	...	3600	.....	150	...	DeLaval Steam Turbine Co.
1	Pump	Duplex	Boiler feed	...	...	....	10x6x12"	150	...	Platt Iron Works
1	Pump	Simplex	Heating system	...	...	....	10x14x20"	150	...	American Steam Pump Co.
1	Heater	Open	Feed water	...	...	....	...		2400	Warren Webster & Co.

and the exhaust from all, with the exception of the fire pumps which are piped to the atmosphere, is collected in a 10-in. auxiliary exhaust main which connects with the feed-water heater and the heating main.

Exhaust steam from each main unit is connected with its condenser through a 24-in. pipe, fitted with a hydraulically operated gate valve and with the atmosphere through a 15-in. exhaust stack, and with the 18-in. heating main to the works through a 12-in. pipe. The heating main is also connected with the bleeder on each main turbine through a 12-in. pipe and with the auxiliary-steam header through an 8-in. connection and a reducing and regulating valve.

The 18-in. heating main extends 135 ft. through a 10x7-ft. reinforced-concrete-lined tunnel, and feeds branch lines to the 22 buildings of the works, which contain a total of 60,000 sq.ft. of direct and indirect radiation used for heating, including the drying kilns.

Switchboard and Wiring

The switchboard consists of eight panels of black unpolished slate. Three panels at one end carry the dynamo-controlling and registering instruments. A fourth panel carries a graphic recording and indicating wattmeter and a Tirrill regulator. The other four panels carry the ammeters and nonautomatic, distant-mechanical control oil switches for the various distributing circuits. The direct-current busses are mounted directly behind the board, while the alternating-current busses and oil switches are mounted on pipe racks located beneath the switchboard in the basement.

Eight lead-covered paper-insulated feeder cables of 600,000 circ.mils, running through the tunnel on insulator racks, carry the power current to the various distributing panels in the works; four cables of the same type, but of 300,000 circ.mils, carry the current for the lighting circuits. There are some 10,000 tungsten lamps in the works, ranging in capacity from 25 to 100 watts.

The writer is indebted to Louis Kahn, superintendent of mechanics, for courtesy extended and assistance given in preparing this article.

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Device Prevents Sway of Elevator Cables

By William Kavanagh

SYNOPSIS—A description of a simple device to prevent swaying of the cables and the trouble caused by swaying cables in deep elevator shafts.

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The hoisting or lifting cables of elevators are likely to leave the grooves of the winding drum from any one of the following causes: First, if the drum unwinds too much; second, if the brake should close on the brake wheel while the car is in rapid motion; third, if the sway or side lash given to the cables is conveyed to the hoisting drum. Any or all of those three reasons will cause the cables either to become loose or ride on the neighboring convolutions, which, of course, will cause more or less trouble. Sometimes a sudden reversal of direction of motion of the car will cause the cables to sway and in numerous cases this sway is caused by a quick stop or start of the car, which may cause the cables to jump out of their grooves. The car must then be stopped to place the cables in the proper grooves.

To do this the try-out or "baby switch" is thrown over for hand operation from the control board and the car is lowered until the cables are unwound and placed in their proper position on the hoisting drum.

When buildings are high or moderately so the swaying of the cables is often a great source of annoyance and when the hoisting mechanism is placed in the cellar or basement of the building, the swaying of the cables is augmented. Owing to their increased length, the cables are more likely to jump out of their grooves. To offset this sway effect the device in Fig. 1 was installed and operated with success.

This sway absorber is placed on the wall of the elevator

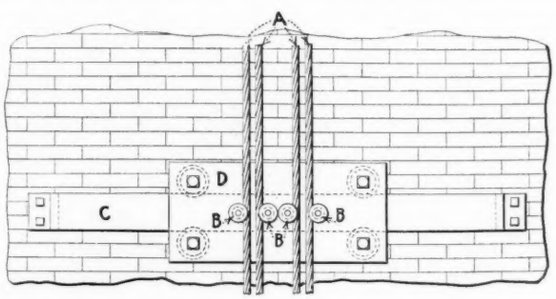


FIG. 1

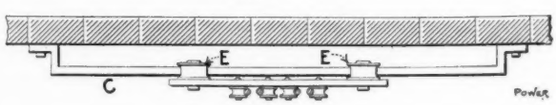


FIG. 2

Device to Prevent Swaying of Elevator Cables

shaft. The hoisting cables *A* move up and down between the wheels *BBB*. A flat bar of machinery steel *C* is fastened to the shaft wall. On this bar or guide rides the oblong apron *D*, which serves as a frame for the wheels *EE*, Fig. 2, which roll on the bar *C*. The apron wheels

are also shown dotted in Fig. 1. The cable guide-wheels through which the cables move are retained in position by small bolts, which act as axles. These wheels, of course, have curved faces to suit the curvature of the cables and they can be put in place or removed by taking out the axles, which are provided with oil holes for the purpose of lubrication.

The machine is erected in the shaft a distance from the hoisting drum equal to about one-third the height of the building, and it is free to move in a horizontal direction either toward the right or left, thus compensating for the angular or horizontal travel of the cables as they are wound on or off the drum, the machine can be embedded in the wall if necessary or it may stand out from the wall any desired distance.

As the device is built wholly of iron and steel and also being free to move, its weight offers just enough resistance to prevent the cables from swaying appreciably.

Putting New Stems in Corliss Valves

By H. R. Low

SYNOPSIS—The author gives full and comprehensive directions for putting new stems in Corliss valves without disturbing adjustments, although keyways must be located and cut in each valve stem.

The first thing to consider before preparing to mark off the new keyways is the way the T-head on the stem fits the slot in the end of the valve. Should this be too loose a fit, it will not only cause a disagreeable click, but the noise will grow louder as the wear increases, and, besides, lost motion at this point causes a late valve opening. The fitting should be done when the valve and new stem are of the same temperature.

Take off the back bonnet and draw out the valve. Scrape the T-head to a good, snug (not tight) fit. Use a try square from the end of the valve along both sides of the stem to see that it lines up properly, for if it stands off at an angle, it will bind in the gland and bonnet guide, and must be scraped into alignment. It does not require much scraping at this point to make a considerable difference in alignment.

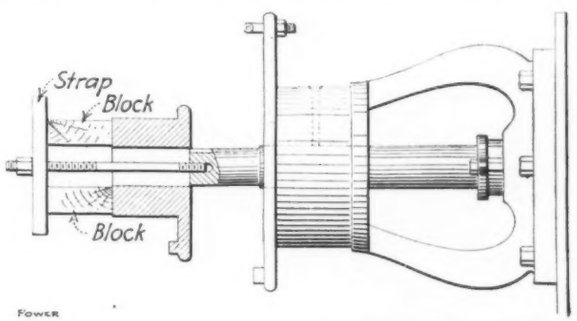
After being satisfied that the stem is parallel with the body of the valve, place the valve back in the port, see that the dashpot plunger is down "solid" on the bottom, and the valve (we are considering the steam valve now) is on the lap. Secure the valve in this position by driving a wedge in between the valve and its chamber. A piece of copper makes an excellent wedge for this purpose. Measure the lap with a pair of dividers to check up with when the job is finished.

The writer is assuming that the reader is aware that underneath the back bonnets, on the face of the valve chambers, and on the end of the valves, are marks or lines which correspond with the opening edges of the valve and port.

Having secured the valve in position, take off the front bonnet and remove the old stem. See if it is numbered or lettered. Whether it is or not, put a good, plain figure on the new stem corresponding to that on the valve. This will lessen the chances of becoming confused should two or more stems be sent to the shop at once. Now try the new stem in the bonnet to see that it fits correctly in the guide, then put the bonnet and stem back in the cylinder in position.

Place the crank on the end of the stem, tapping it lightly or just enough to hold it, taking care that the valve does not move while placing the pin hole in the crank in line with the hole in the end connection of the dashpot rod. When these two holes are in line the crank will be in the correct position and you are ready to mark the keyway. With a sharp-pointed scriber or knife blade mark the stem from the keyway in the crank. Take out the stem and with a try square or surface gage carry out the lines the required length on the stem.

These lines can be marked off with great accuracy by placing the stem on centers and using a surface gage from any straight surface. The keyways in the exhaust-valve stems can be laid out from any position of the valve and gear if care is taken to prevent the valve from moving by using the copper wedge, as described above. The gear may be secured by putting a piece of cardboard between



Ready to Force Crank on Corliss Valve Stem

the hub of the wristplate and the washer, setting the nut up firmly. Also see that the check nuts on the reach rods to the wristplate are tight against the end connections to prevent the rods or ends turning. The bonnet and its parts can be assembled complete and the keys fitted while these parts are off the cylinder, thus removing any danger of moving the valve out of its position by pounding or jarring. Should it be desired to assemble the parts with the bonnet in position on the cylinder, the following method of putting on the crank may be used with good results. Drill a hole in the end of the stem, the size of which should be in proportion to the size of the stem and the work it is to do. Assume a stem with the end 1½ in. in diameter where the crank fits.

With a $\frac{7}{16}$-in. drill go deep enough to give a full thread with a ¼-in. pipe tap. Take a piece of cold-rolled steel $\frac{9}{16}$ in. in diameter, and, say, 7 in. long. Taper one end slightly and cut a thread on this end with a ¼-in. pipe die. Thread two-thirds or more of the remaining length with a $\frac{9}{16}$-in. standard die. With two nuts, one checked up hard against the other, this draw bolt can be screwed firmly into the end of the stem.

Start the crank on the stem, using a stick that is just

the width of the keyway to place the keyways in line. Now make a strap of a piece of iron or steel, drill a hole in the center large enough to go over the draw bolt, several washers if large enough in diameter will answer the purpose. Take two or three parallel blocks of hard wood or steel, somewhat larger or wider than the width of the crank and put them between the strap and the face of the crank hub, just clearing the edge of the hole. By screwing up on the nut, the crank should be forced on easily and without leaving a mark. The illustration shows the crank in position and ready to be forced on the stem.

The draw bolt can now be removed from the stem by means of the two nuts locked against each other without injury to the threads. The hole in the end of the stem can be fitted with a plug made by simply cutting a ¼-in. pipe thread on a piece of cold-rolled steel, and sawing a screw-driver slot in it by which it can be screwed into place, and when finished off flush and polished, makes a very neat and much more finished appearance than a center hole.

❖ ❖

Results of Tests of Spiro Turbines

By Herbert Coward, M. E.

SYNOPSIS—In testing the turbines a fan dynamometer was used, the fan being run open in the air without housing, thus giving a constant load at a given speed. Results of the tests are indicated by the several curve sheets.

❖

Early in 1912, when the Spiro turbine was first introduced to the public, some performance results were published which became the subject of considerable discussion. The tests on which these figures were based were made noncondensing, or rather condensing at zero vacuum and back pressure, and resulted in a water rate as low as 31.8 lb. per b.hp.-hr. on a 150-hp. turbine.

Since the ordinary types of turbine running under these conditions have water rates from 45 to 55 lb. per b.hp.-hr., these figures were received with considerable scepticism, which caused the manufacturers to undertake an extensive series of tests, not only to verify or disprove the original test results, but to determine the characteristics of the motor under varying conditions of load, speed, etc., so that dependable data might be had to suit the widely varying requirements met with in actual service.

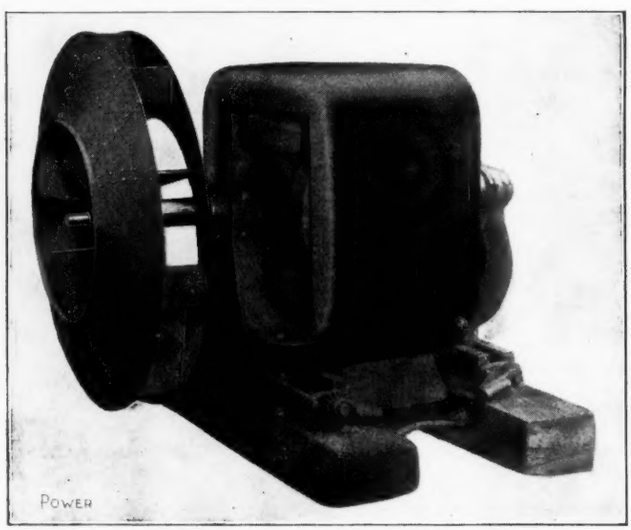


Fig. 1. Fan Dynamometer and Motor

It was arranged with the writer to undertake this series of tests which are now in progress and partial results of which are published in the following. It is the intention to follow the zero back-pressure tests with others at various vacuums, and preliminary vacuum tests indicate very interesting economies. Arrangements are also under way with two prominent universities who will each make independent tests on several sizes of Spiro turbines.

To apply load to these turbines of various sizes in order to secure curves covering a wide range of speed and pressure variables, it was necessary to devise a proper dynamometer. This was done by selecting a number of sizes of air-blast wheels, or fans, with diameters ranging from 8 in. to 4 ft., especially rugged in construction to stand up under heavy absorption.

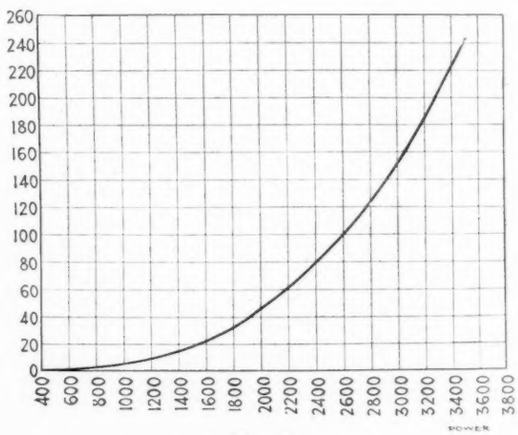


Fig. 2.

In calibrating these so called fan dynamometers, several interesting facts were observed. It may not be known to the majority of readers that a blast wheel run open in the air, as we run these dynamometers, requires from 200 to 260 per cent. more power at a given speed than when in a housing under working conditions. The fact that the load builds up so rapidly in free air and that it is absolutely constant at a given speed, barometric pressure, temperature and humidity, makes the blast-wheel dynamometer ideal for speeds between 1000 and 5000 r.p.m. The correction for barometric pressure, humidity and temperature are direct corrections, involving no guesswork or estimating; on the whole, this type of dynamometer, if carefully calibrated to start with, is more accurate than any other type of absorption dynamometer.

In Fig. 1 is shown a blast-wheel and variable-speed test motor ready for calibration. In order to avoid the possibility of error, the established efficiency of the motor was disregarded, armature current only was read, and the result corrected for no-load current and I^2R loss for each load and speed condition, the resulting figures being the

net total watts input into the wheel necessary to attain each speed.

From these results curves were plotted for each wheel with horsepower as ordinates and r.p.m. as abscissas. One of these curves is reproduced in Fig. 2.

The arrangement for making tests is shown in Fig. 3. Steam is first put through a separator and, after passing

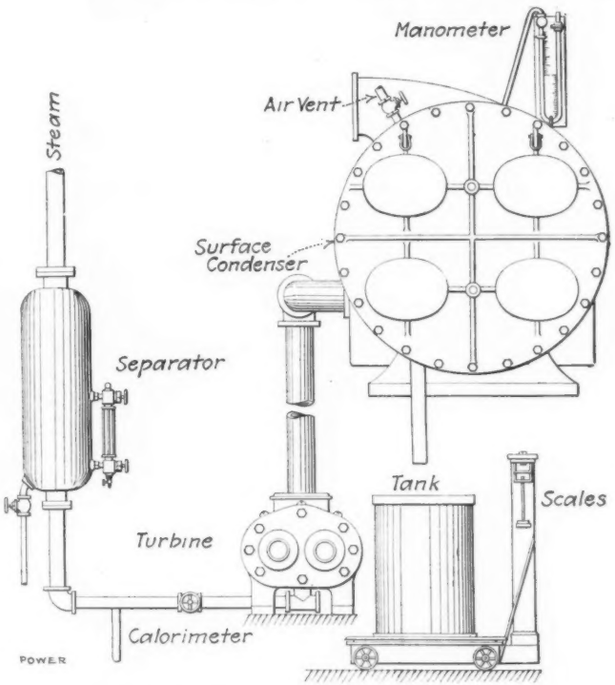


FIG. 3. SPIRO TURBINE, CONDENSER AND PIPING

a calorimeter enters the turbine. From the exhaust it is led to a surface condenser arranged with an air vent to break the vacuum and give atmospheric conditions which were further determined by a U-tube manometer capable of indicating the slightest amount of pressure or vacuum.

The condensate was allowed to flow out of the condenser into a tank mounted on scales.

Over 100 tests are made on each size turbine at varying load, speed and steam pressure. The results of the tests for a 6-hp. turbine at 100 lb. pressure are shown in Figs. 4 and 5, the first being the variation of horsepower with revolutions per minute and the second, the variation of water rate with revolutions per minute and horsepower. It is interesting to note that the absence of loop on either curve indicates that conditions of maximum economy have not as yet been reached. The curve, Fig. 4, shows how the power increases with the speed. As this curve varies but slightly from a straight line, the horsepower approximately varies directly as the speed. The direction and nature of the curve at its highest point indicates that the maximum power has not been reached. In Fig. 5 the curve shows how the steam consumption decreases with an increase of speed. As this curve still has a downward direction at the highest speed it indicates that the point of maximum economy was not reached within the limits of this test.

Curves, Figs. 6 and 7, are for the 100-hp. turbine and show respectively the variation of horsepower with pressure, and the variation of water rate with pressure. Fig. 6 curve shows how the horsepower increases with the steam pressure. One hundred pounds pressure was the maximum available at the place and time of this test, but the nature of the curve indicates that considerable higher

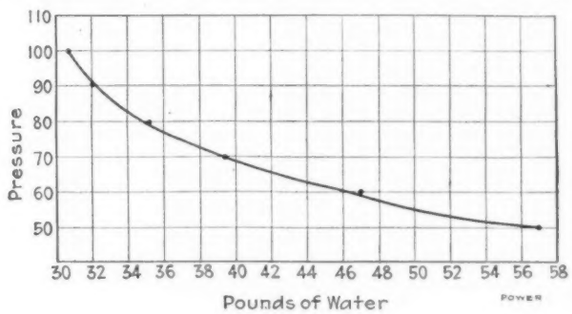


FIG. 7.

pressure could be used. In Fig. 7 the curve shows how the steam consumption decreases with increased steam pressure. As it was seen from Fig. 6 that the maximum pressure has not been reached, still better economy can be expected at the higher pressures.

These examples, taken at random from the tests so far completed, seem to prove conclusively that the Spiro turbine is an exceedingly economical motor.

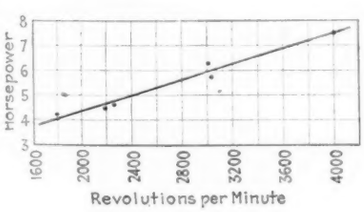


FIG. 4.

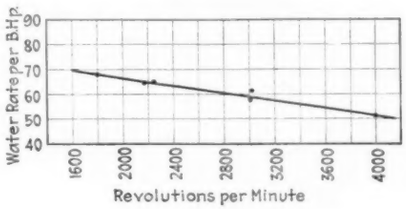


FIG. 5.

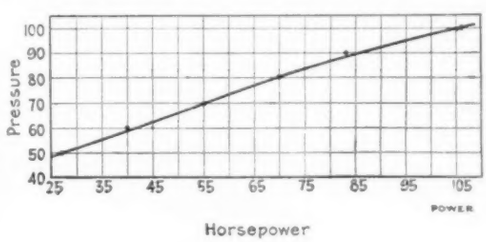


FIG. 6.

There is being built at Beldens, Vt., for the Vermont Marble Co., of Proctor, a new power plant, for furnishing electric power to the quarries in the neighborhood of Proctor, 40 miles away. There are to be two units of 1200 hp. each, directly connected to 800-kw. Westinghouse generators and running at 300 r.p.m. Each unit is a 1200-hp. double turbine manufactured by the S. Morgan Smith Co., York, Penn., the turbines having runners 33 in. in diameter, on a horizontal shaft, and the flow of water being controlled by the familiar wicket-gate system. The discharge from the turbines runs through a draft tube 16 ft. in depth.

This plant is practically a duplicate of a plant built in 1910 at Huntingdon Falls, about two miles from Beldens. Both plants will operate over the same set of transmission lines at high voltage, all of the power being used in the neighborhood of Proctor.

The University of Cincinnati shortly after the flood detailed Prof. A. Wilson and six senior students of the electrical course to go to Hamilton, Ohio, and assist in the rehabiliation of the power plant and water-works. The students rendered valuable assistance in getting both systems in operation again within the week.

Nordberg Long-Range Valve-Gear

SYNOPSIS—This valve-gear is designed to give a long-range cutoff without the customary two eccentrics. The mechanism of the governor and the cutoff gear, which is operated by a separate eccentric, makes this possible. A valve-gear of different design is used on engines running at a speed of 150 r.p.m. or more.

The Nordberg, long-range, valve-gear, Fig. 1, secures a long range of cutoff without the aid of a double-eccentric gear. The arrangement of drop arm, valve arm and hook are essentially the same as in the Nordberg standard gear. There is, however, a difference in that the hook *D* is positively thrown in and out of engagement with the drop arm *H* by means of a lever *G*, which terminates, through a roller *R*, in an oscillating cam *E*. This cam is hung on an extension *C* of the valve arm *ABC* and has two concentric circular slots whose center is the point of suspension of the cam. The two circular slots are joined by a transition slot. When the roller passes from one slot to the other, the hook is released or engaged. No relative motion between the cam and roller is produced by the motion of the wristplate, that is, with the engine standing still and the wristplate rocked through its entire range, the trip steels remain stationary relative to each other.

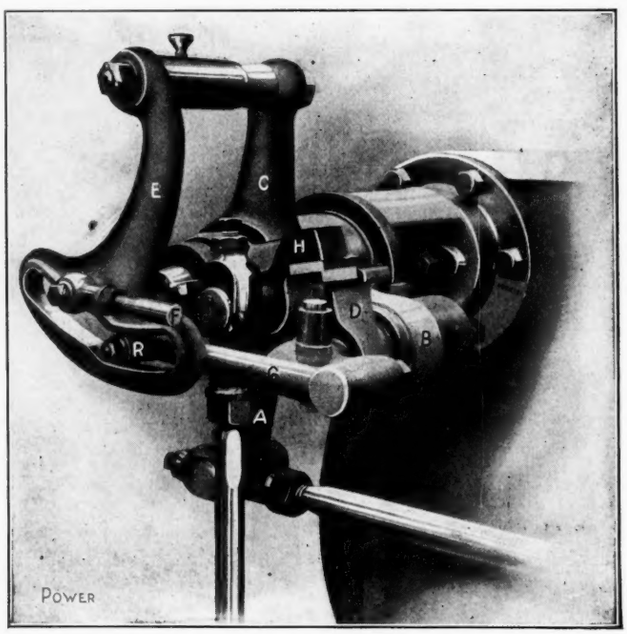


FIG. 1. NORDBERG LONG-RANGE VALVE-GEAR

The cam *E* is oscillated about its point of support through a cutoff rod *F*, which receives its motion from a separate eccentric, the throw of which corresponds approximately to the length of each of the circular slots. If the engine is running below normal speed and the governor is resting on the collar, the roller remains in the lower slot, the hook steels remain in contact and steam is admitted the full stroke of the piston. With the engine at normal speed and no load, the governor is in its highest position and the roller remains in the upper slot of the cam, the trip steels remain disengaged and no steam is admitted to the cylinder. The cutoff takes place coincident with all the intermediate positions taken by the governor, which changes the center of oscillation of the cams, between the two extreme limits described.

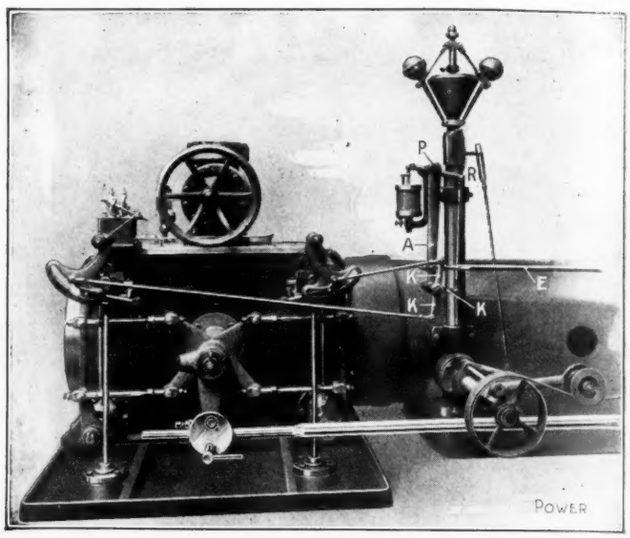


FIG. 2. LONG-RANGE VALVE-GEAR AND GOVERNOR

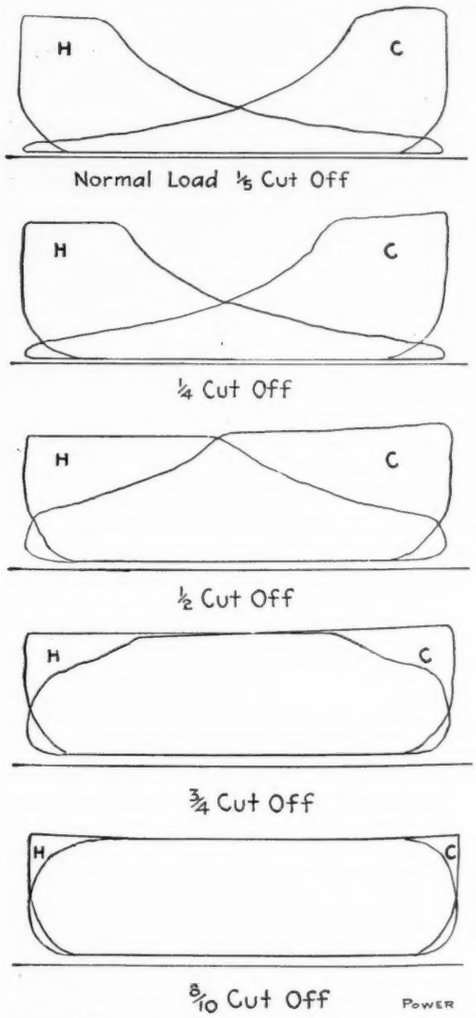


FIG. 3. DIAGRAMS SHOWING VARYING CUTOFF

The center of oscillation of the cams is controlled by the governor in such a manner as to free it from any reaction due to movement of the knock-off eccentric. For this purpose the motion of the governor and eccentric is transmitted to the cams through the mechanism illustrated by Fig. 2. This consists of a parallelogram whose main lever is supported by a bracket on the governor, free to swing about the point P, and which is driven by the knock-off eccentric rod E. At the bottom end of this lever is hung the three-armed lever K, the two vertical ends of this lever being connected to the knock-off cams and the horizontal arm connected by a rod parallel to the main lever A, the upper end of which is connected to the governor at the point R.

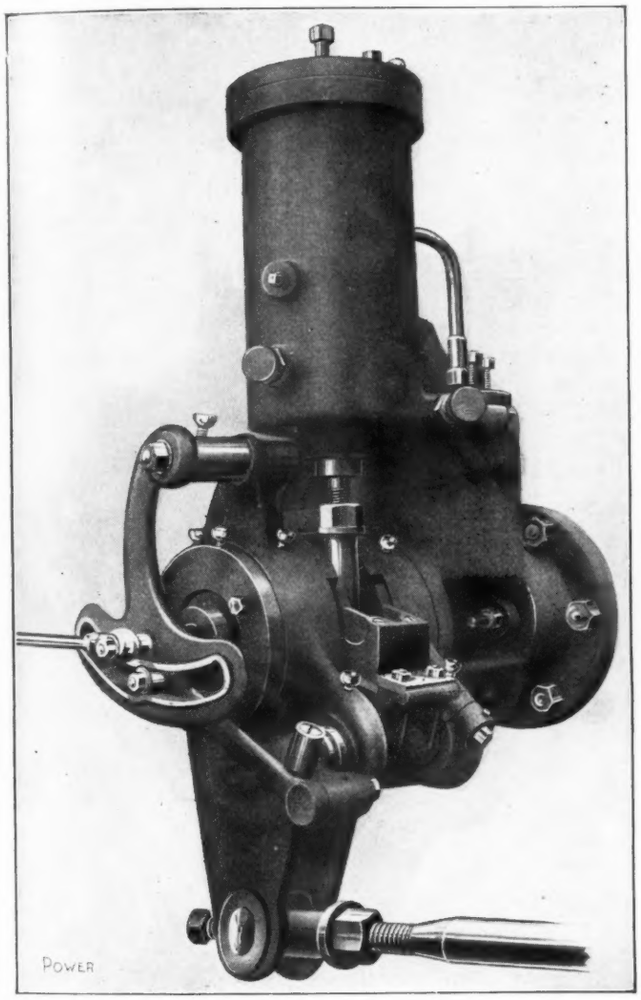


FIG. 4. NORDBERG HIGH-SPEED VALVE-GEAR

As this parallelogram is oscillated by the knock-off eccentric-drive rod, its sides remain parallel, therefore, the lever K always moves in a position parallel to itself. Should a change of load occur, the governor lifts or lowers the point R, thus changing the angularity of the lever K and changing the center of oscillation of the cams and the point of cutoff.

Fig. 3 shows five cards from a Nordberg Corliss engine, fitted with long-range gear, manufactured by the Nordberg Manufacturing Co., Milwaukee, Wis. These cards show the wide range of cutoff obtained under full control of the governor. At normal load the cutoff is at $\frac{1}{4}$, and this is increased up to 0.8 cutoff with 200 per cent. of the normal load. This feature enables an engine to carry high overloads, and to take care of sudden peak loads without impairing regulation. Again, it permits an engine to carry heavy loads with the steam pressure below normal.

The gear shown in Fig. 2 is well adapted for high speed of rotation, because engagement and release of the trip steels is positive and effected without the aid of springs or gravity. But for engines which are to run at very high speeds, that is, 150 revolutions or more, the type of gear illustrated in Fig. 4 is used. The essential difference between this and the gear for ordinary speeds is that it is symmetrical with respect to a central plane, there being no overhung parts, with the exception of the full-stroke cam. Therefore, there are no bending strains which, at high speeds, become serious in a valve-gear of the overhung type. The valve stem has two bearings in the bonnet outside of the stuffing-box, and the drop arm is keyed to the stem between these two bearings. The end thrust of the stem is taken up by a hardened-steel plate located in the bonnet cap, instead of by a collar.

The bearing surfaces are several times larger than those on the ordinary gear, which reduces wear. The valve-gear has small travel and to secure positive and sharp action, spring dashpots are used, as shown.

In order that the valve-gear may have small travel and at the same time give ample port area, the valves used on engines equipped with this gear are of the Nordberg four-ported type, illustrated by Fig. 5. The combination of this high-speed gear eliminates lost motion, and as the cutoff is controlled by a separate knock-off eccentric, close regulation is secured.

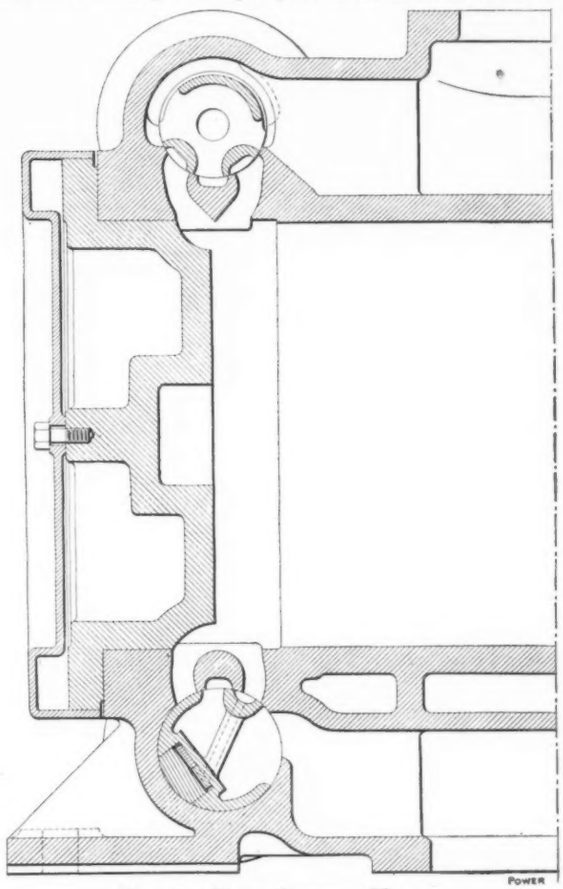


FIG. 5. FOUR-PORTED VALVE

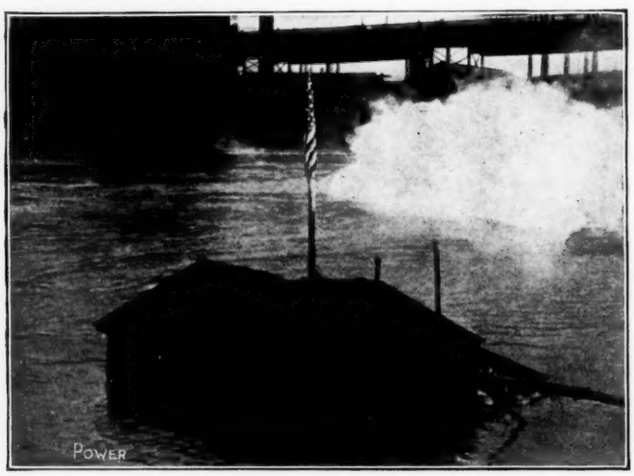
When the exhaust valve is closed, the valve cavity is not thrown into the clearance. It is essential to have small clearance in engines of this type, because with high rotative speed the stroke must be shortened to keep the piston speed within reasonable limits.

❋

Pump Working under Water

By W. S. Standiford

During the recent flood at Youngstown, Ohio, there was one industry, Renners Brewery, that worked continuously throughout the flood period. The pumping station of the brewery, located on the bank of the Mahoning River, was the object of much comment. As the water kept rising, an extension was put on the exhaust pipe of the pump



Pump Operating Submerged under 3 Ft. of Water

to prevent the pipe and pump from flooding, thus forcing a suspension of the plant's operation.

The water completely submerged the building and rose to within 6 in. of the top of the pipe, with 6 ft. of water over the pump. The illustration shows the pump working under 3 ft. of water. As the water receded, an employee crawled out over the pipe line and decorated the pump house with the "Stars and Stripes," in recognition of the services the machine had rendered. The pump house, a substantial structure, withstood the torrent that carried many another building down stream.

❋

Thread-Tight Pipe Compound

A pipe-joint compound which has the approval of engineers is known as "Thread-Tight." This paste has been compounded with the purpose of making threaded joints tight and to not harden after being subjected to the influences of either heat or cold and consequently permit of joints being unscrewed with but little effort.

This paste compound will adhere equally as well to wet as to dry threads; an important thing in the process of repair work. It is also for use on flange joints, being applied in connection with a gasket of thin paper, which is used merely as a means of holding the paste in place until the two flange faces are brought together.

Regarding its adaptability in preventing leakage in screwed joints, one user of the compound states that it was used on a threaded pipe joint made hand tight, no pipe wrench being used, and the joint tested at 350 lb. hydraulic pressure without showing leakage and with a similar result with a steam pressure at 110 lb.

This thread paste is made by the Thread-Tight Co., U. S. Express Bldg., 2 Rector St., New York City.

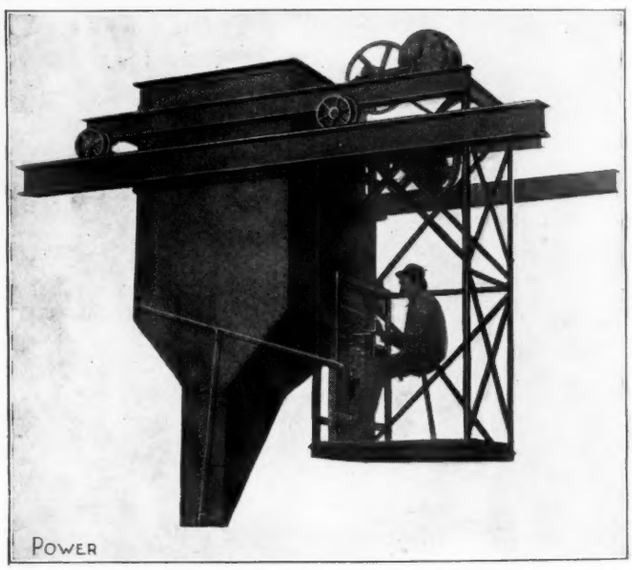
❋

Motor-Driven Coal Hopper

Motor-driven coal hoppers, which can take coal from bunkers located anywhere and deliver it to any boiler in a battery, are coming into favor. Their use does away with the system of overhead bunkers and individual chutes for each boiler, and permits all the coal to be concentrated in one bunker instead of in a series of pockets.

The bunkers can be placed at one end of the boiler room, or, for that matter, outside if necessary, so that the boiler room can be designed and located with greater freedom, and plenty of space left above the boilers for light and air.

The hopper, as shown, runs on a trackway parallel to the front of the boilers and is controlled by an operator in the same manner as an overhead crane. Accurate



Motor-Operated Coal Hopper

scales on the hopper make it possible to keep a precise record of the fuel burned by any boiler. If desired, a recording device can be installed so that a printed record of the weight of every discharge can be made by the operator. The hopper runs under the bunker and is filled by the operator, the scales indicating when the hopper is full. It is then run into the boiler room and delivers the coal where wanted.

This hopper is manufactured by the Bergen Point Iron Works, Bayonne, N. J.

❋

The Toronto Hydro-electric Light and Power Comission has just issued its report of operations for the past year. The gross income amounted to $726,7[illegible]5[illegible]; the cost of generating power, including maintenance, repairs and management was $500,564.26 and interest, sinking fund and depreciation amounted to $212,643.38. This leaves a net surplus of $13,555.91, an excellent showing when it is considered that the commission is just embarking upon its third year of operation

ELECTRICAL DEPARTMENT

Primer of Electricity

A lap-connected winding may be connected to the commutator in either of two ways, commonly termed "right-handed" and "left-handed." A right-handed winding is one that progresses to the right, tracing through each coil from its left-side terminal to its right-side terminal; Fig. 166 illustrates this definition. Here are represented four single-turn coils, *A*, *B*, *C* and *D*, connected to commutator bars right-handedly. Starting at the left-side terminal *a* of the coil *A* and tracing through that coil and the adjacent ones leads the tracer to successive coils and commutator bars to the right of the coil *A* and bar 1. Fig. 167 illustrates the left-handed winding; the progression from coil to coil and bar to bar being to the left of the starting point. In both cases the start is made at the left-side terminal of the first coil (*A*) and the path through each coil is "clockwise."

The following rules are fundamental for simple lap-connected drum windings:

1. The terminals of each coil of the winding must be connected to adjacent commutator bars.

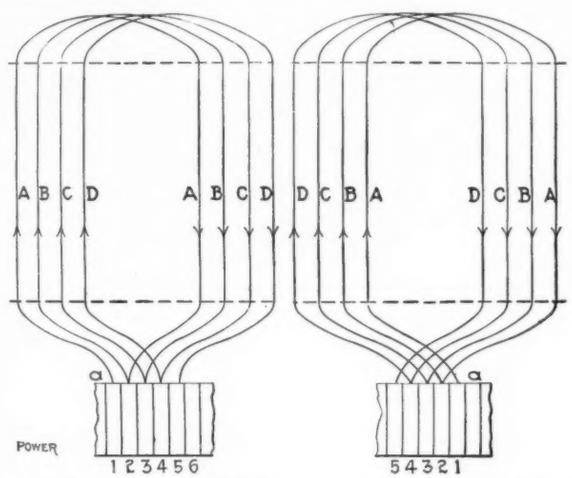


FIG. 166. PART OF A RIGHT-HANDED DRUM WINDING
FIG. 167. PART OF A LEFT-HANDED DRUM WINDING

2. The left-side terminal of every coil must be connected to the same commutator bar with the right-side terminal of the coil next to it in "commutator sequence."

3. In a right-handed winding the right-side terminal of each coil is connected to the same commutator bar as the left-side terminal of the coil next in commutator sequence to the *right* of it. (To the right means in the clockwise direction around the core, facing the commutator.) See Fig. 168, where the right-side terminal of the coil *AA'* is connected to the same bar as the left-side terminal of the coil *BB'*, which is next to the right of it in commutator sequence.

4. In a left-handed winding the right-side terminal of each coil is connected to the same commutator bar as the left-side terminal of the coil next to the *left* of it in commutator sequence. See Fig. 169, where the right-side terminal of the coil *AA'* is connected to the same bar as the left-side terminal of the coil *BB'*, which is next to the left of it in commutator sequence.

"Commutator sequence" is the sequence in which coils are connected to the commutator. Referring to Fig. 170, for example, the coil *B* is next to the coil *A* in commutator sequence because its left-side terminal is connected to the commutator bar next to the one to which the left-side terminal of the coil *A* is connected. The coil side lying between the sides of the coils *A* and *B* is of the opposite

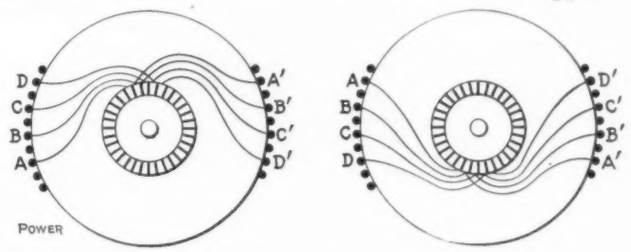


FIG. 168. PREFERRED ARRANGEMENT OF RIGHT-HANDED COIL TERMINALS
FIG. 169. PREFERRED ARRANGEMENT OF LEFT-HANDED COIL TERMINALS

"hand"; that is, the coil side between the left sides of the coils *A* and *B* is a *right* side, and the coil side between the right sides *A'* and *B'* is a *left* side. Their terminals lead away from those of the coils *AA'* and *BB'*, as indicated by the dotted lines.

In order to produce the smallest number of overlappings between the terminals leading from the armature to the commutator of a bipolar machine, the terminals in a right-handed winding must be led to bars in the upper half of the commutator (the coil being in a substantially horizontal plane); the reverse is true for a left-handed

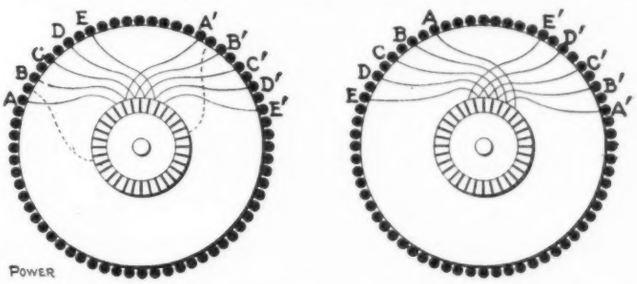


FIG. 170. RIGHT-HANDED CONNECTIONS FOR FOUR POLES
FIG. 171. LEFT-HANDED CONNECTIONS FOR FOUR POLES

winding. Figs. 168 and 169 illustrate these conditions. If the winding in Fig. 168 were connected left-handedly, the terminals of each coil would cross each other between the armature and the commutator, because the right-side terminal of coil *CC'* would have to be connected to the same bar with the left-side terminal of coil *BB'*, and so on. This would be true also of Fig. 169 if the connections were changed to right-handed.

In all multipolar machines, the winding must be of the right-handed type to avoid having the terminals of each coil cross each other. Figs. 170 and 171 illustrate this; in the former, representing a right-hand winding, the

terminals of any one coil do not cross each other, whereas in Fig. 171, representing a left-handed winding, the terminals of every coil cross each other. These windings are for an armature to work with a four-pole field magnet.

A dynamo or motor will operate just as well with a left-handed as with a right-handed winding, but either the brush polarities or the direction of rotation will be reversed. Fig. 172, for example, shows the correct brush polarities for clockwise armature rotation with a right-handed winding connected as shown in Fig. 168; if the winding were connected left-handedly, the brush *A* would be positive and the brush *B* negative, and the connections between the brushes and the field winding would have to be reversed in order to maintain the same field polarity; or else the direction of rotation would have to be reversed in order to keep the brush polarity unchanged.

The brush position here represented is correct for a

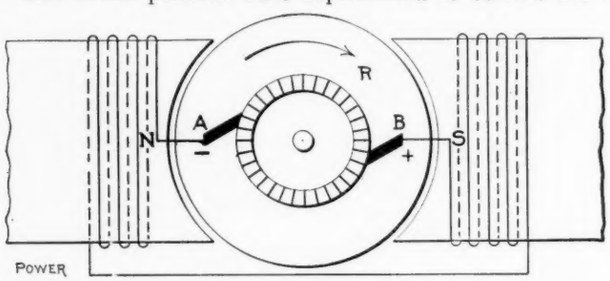


FIG. 172. BRUSH POSITIONS AND POLARITIES WITH SYMMETRICAL COIL LEADS

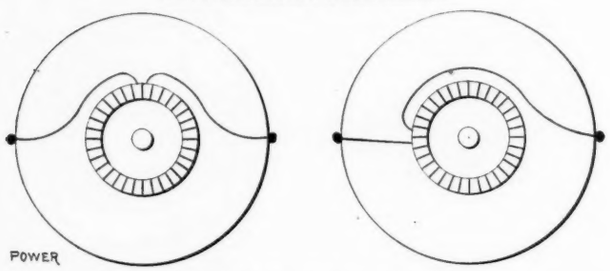


FIG. 173. SYMMETRICAL COIL LEADS

FIG. 174. EXTREME BACKWARD UNSYMMETRICAL LEADS

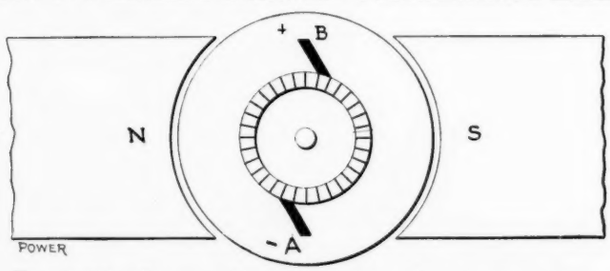


FIG. 175. BRUSH POSITIONS AND POLARITIES WITH EXTREME BACKWARD UNSYMMETRICAL LEADS

winding in which the two leads or terminals of each coil are of equal lengths, as illustrated in Fig. 173. If the left-side lead were brought straight out from the left side to the commutator, parallel with the armature shaft, the right-side terminal would have to extend almost across the armature head to reach the proper commutator bar, and the two bars corresponding to any one coil would be almost in line with the left side of the coil, as in Fig. 174. Consequently, the brushes would have to be located as shown in Fig. 175. The effect is as though the coils had been connected symmetrically, and the commutator twisted backward nearly 90 deg., making it necessary to shift the brush position backward to the same extent.

Changing from Sixty to Twenty-five Cycles

In a plant using alternating current at 60 cycles it was recently necessary to have available current at a frequency of 25 cycles. The infrequent demand for it and the small quantity required did not warrant the purchase of a machine for that purpose so it was decided to obtain it from a 60-cycle apparatus on hand.

A three-phase, 15-kw., 115-volt, 60-cycle, 6-pole, revolving-field alternator with direct-connected exciter was pressed into use for this service. To produce a frequency of 25 cycles the speed was reduced from 1200 to 500 r.p.m. As the field of the exciter was designed for 125-volt excitation, it was impossible to build up the field to normal strength with the direct-connected exciter, due to

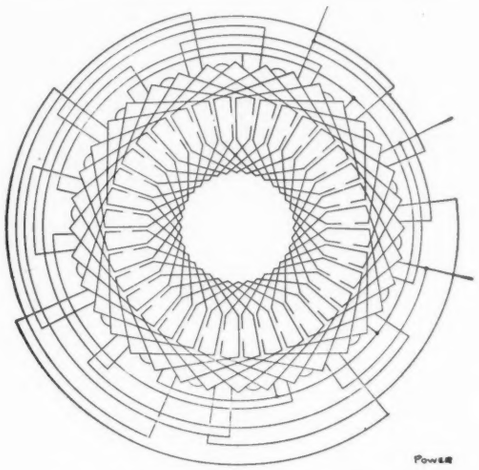


FIG. 1. PARALLEL-STAR WINDING

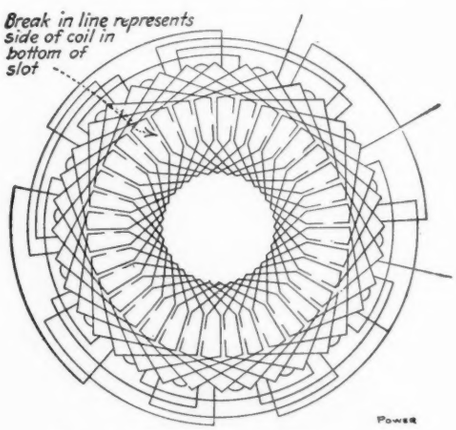


FIG. 2. SERIES-STAR WINDING

the reduction in speed. The brushes were therefore removed from the commutator of the exciter and the two slip rings were connected to a 110-volt, direct-current supply circuit with the rheostat in series. This arrangement gave about 50 volts alternating current across any two of the three leads of the generator, which was too low for the purpose. An examination of the alternator armature showed the windings to be connected parallel-star, as in Fig. 1; this was changed to series-star, as in Fig. 2, doubling the number of turns in series and consequently the voltage. Cutting out resistance with the rheostat easily raised the voltage to 120 volts, which was ample for the purpose for which it was required.

GAS POWER DEPARTMENT

The Illmer Two-Stroke-Cycle Gas Engine

The first gas engine of American origin to employ the double-acting, two-stroke cycle has recently been put out by the Reading Iron Co. from the designs of Louis Illmer, Jr., who has devoted the past eight years toward perfecting this product.

The engine is of the slow-speed type, designed for heavy-duty service along the lines of steam-engine practice, and the aim throughout has been to reduce to a minimum the number of working parts, the theory being that a multiplicity of working parts greatly increases the liability to shutdown. In carrying out this idea a number of unusual features have been embodied.

In the first place, all previous applications of the double-acting, two-stroke cycle have employed separate air and gas pumps. In the Illmer engine, however, this work is accomplished by a single pump of the double-acting type, the stratification principle being employed in scavenging and in the admission of the charge.

A second mark of individuality is the valve gear, which is a distinct departure from usual practice. This is positively actuated by means of an eccentric drive, the inlet valves being opened and closed by a double-toggle linkage, as shown in Fig. 1; there is a total absence of springs, except for the small ones on the igniters. In this way properly accelerated and retarded movements are imparted to the valves and cause them to seat gently, the valves being pressed on their seats by a slight springing of the rocker shaft. Provision is made for independent adjustment by having all the link pins bronze bushed and the links provided with keepers to allow for wear. The pump valves are actuated direct from the wristplate.

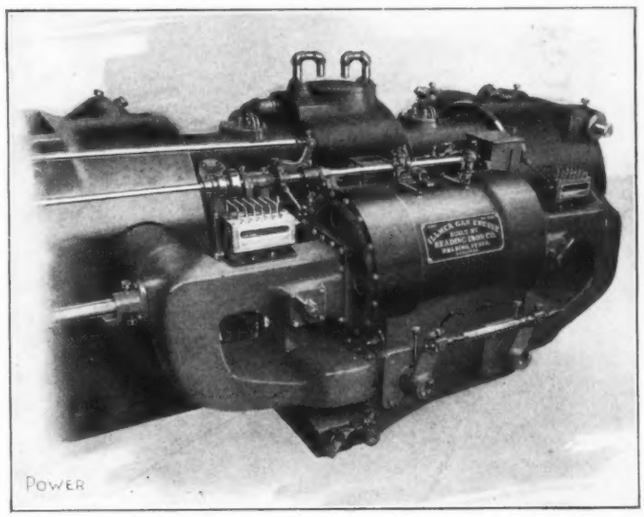


FIG. 2. PUMP SIDE OF CYLINDER

As the engine is of the two-stroke-cycle type, there are, of course, no exhaust valves.

The inlet valves are of the annular poppet type, coaxial with the cylinder, and that on the crank end surrounds the piston rod (see Fig. 3). They slide in housings, and suitable packing is provided. This arrangement permits a large inlet port opening into the power cylinder (about 25 per cent. of the piston area) and thus tends to reduce the pump work, which is said not to exceed 5 per cent. of the indicated power of the engine.

Replaceable liner sections are fitted to the power cylinder, and the exhaust ports, drilled into the inner liner ends, are surrounded by an annular exhaust chamber cast

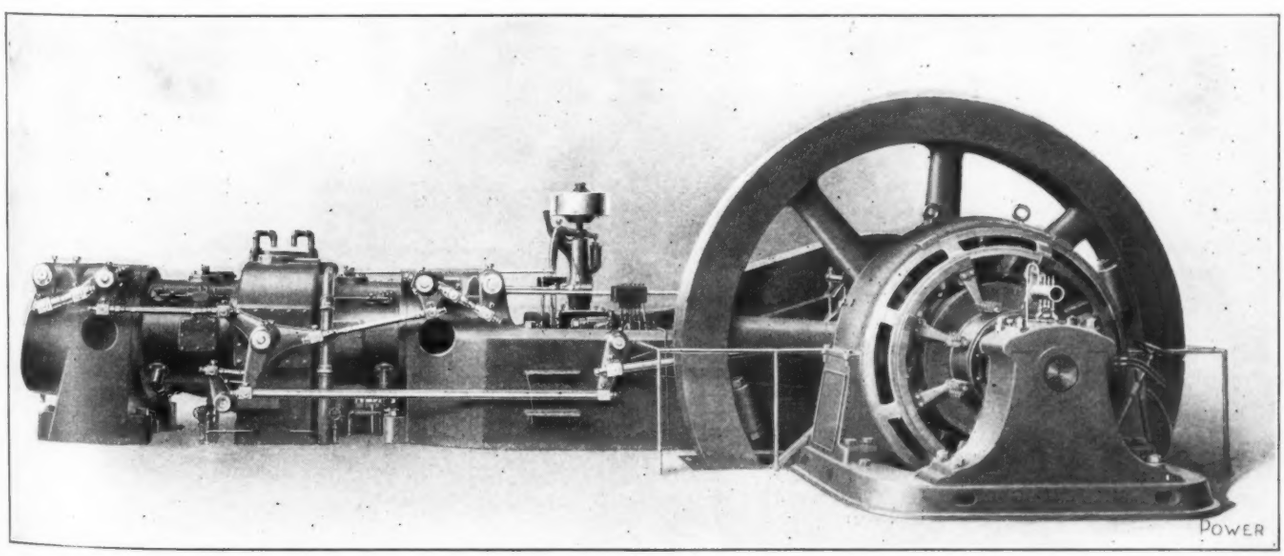


FIG. 1. VIEW OF ENGINE, SHOWING VALVE-GEAR

integral with the cylinder. A handhole in the exhaust chamber admits of cleaning the exhaust ports and also provides a means for inspecting the piston rings.

The engine is of the side-crank type, a drag crank being provided for driving the pump piston and the governor.

Pump Details

Fig. 2 is a view of the cylinder from the pump side, and Fig. 3 is a section through the power cylinder, inlet valves, pump cylinder and ducts representing that position in which the air and gas are being drawn into the pump on the head end (right) and the charge forced into the working cylinder on the crank end (left).

Following through the pump cycle, first consider only the head end with the pump piston just beginning its travel toward the left. The valve *V* would then be rotating counter-clockwise, so as to uncover the ports *A* and *D*; *B* and *C* already being open. This permits air to be sucked through *A* and *B*; also, residual air from the previous charge, which has remained in the upper part of duct *F*, is drawn into the pump cylinder through passage *G*. The latter creates a suction in duct *F*, and draws in gas through ports *C* and *D*, the height to which the gas rises in *F* depending upon the governor, which controls the throttle valve *T*. The air lying behind the inlet valve in the pocket *I* is not displaced by the suction of the pump, but remains in this position during the entire period of inlet closure to be introduced into the power cylinder as scavenging air ahead of the next charge. The relative positions of the air and gas when the pump piston has just passed midtravel on the suction stroke, are indicated in the sketch (head end).

By the time the pump piston has reached the end of its stroke, the valve *V* will have rotated in a clockwise direction so as to close ports *A* and *D* and start to open port *E*. During the first part of the return or discharge stroke the charge is compressed slightly. Just previous to the pump piston reaching midstroke the power piston uncovers the exhaust ports and simultaneously the inlet valve opens.

Port *E* is now entirely uncovered and a free passage is established between the pump cylinder and the lower end of duct *F*. Hence part of the air is forced through ports *B* and *E*, pushing the column of gas ahead of it and at the same time the rest of the air is forced through passage *G*, around *F*, and meets the gas at the mixing ports *H*.

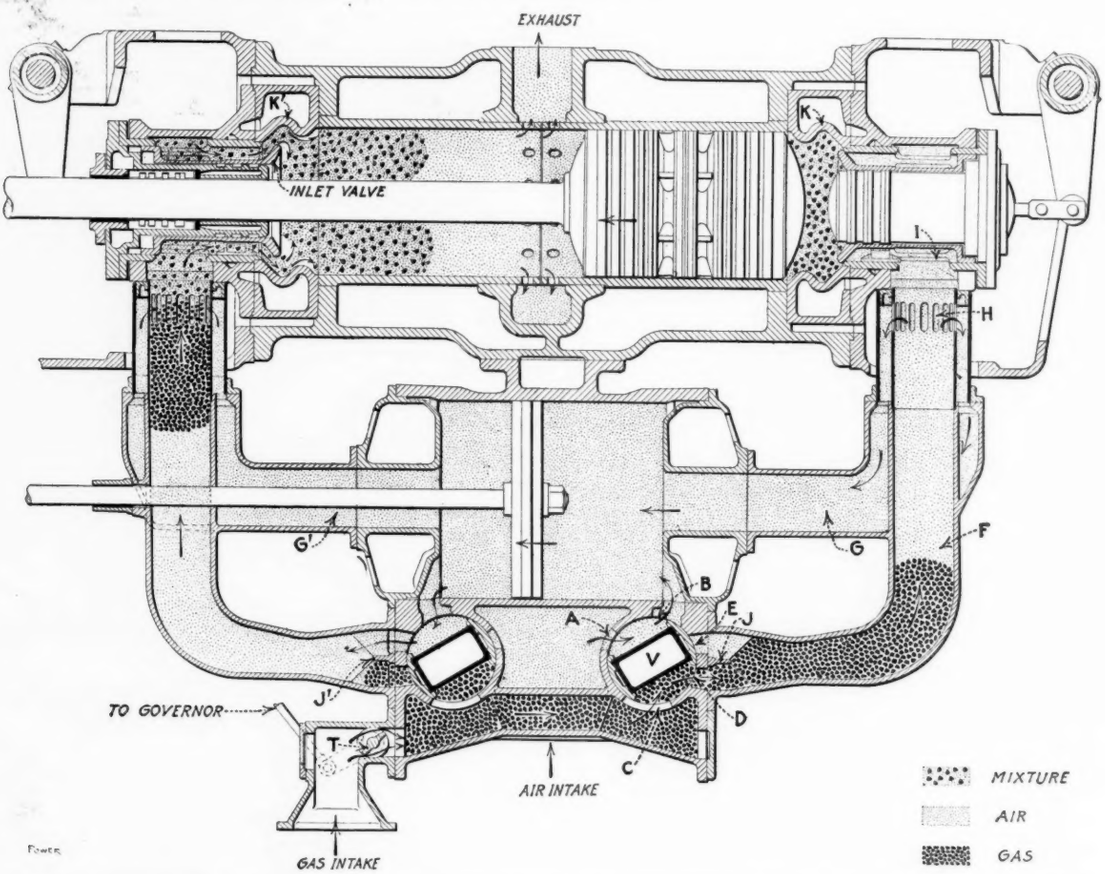


Fig. 3. Section through Cylinder and Pump, Illustrating Stratification of Charge

The residual air in the pocket *I* and any air ahead of the body of gas will have been forced ahead of the mixture to scavenge the cylinder of burnt gases. The crank-end view of Fig. 3 represents the position taken by the mixture charge at the instant of entering the power cylinder.

When the inlet valve closes, the mixture will have been forced into the power cylinder and the air lying behind it serves as scavenging air for the next charge.

A bypass (not shown) connects the two ends of the pump. By setting the valve in this the air may be so regulated as to control the position of the mixture within the power cylinder.

The air-check valve (not shown) in the passages *G* and

G opens inward, so as to provide a free passage of air toward the pump. On the discharge stroke of the pump the check closes and the air has to pass around the valve, the opening being made adjustable by the setting of a lever. Accordingly a relatively large body of gas may be sucked into the duct F without being affected perceptibly by any throttling adjustment made for the air discharge through the connections G or G', whereby to adjust the ratio of air to gas in the mixture charge.

The purpose of the walls J and J is to form pockets, which cause the air to eddy and spread before discharging into the neck of the ducts.

An important feature of the power-cylinder design are the lugs of baffles K and K'. The charge enters the cylinder in the form of a hollow cone around the inlet valve, and strikes the baffle K or K' approximately normal to its direction of flow. This causes the mixture to whirl

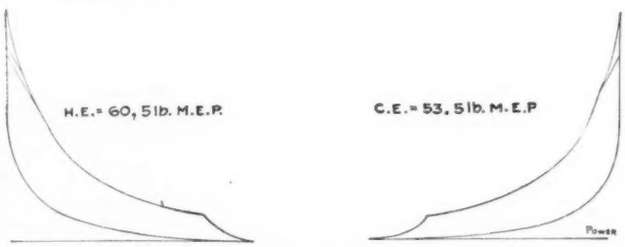


FIG. 4. POWER-INDICATOR DIAGRAMS FROM CYLINDER

and lose much of its velocity spreading over the cylinder and driving out the scavenging air.

Proper spreading of the charge is largely facilitated by a new principle embodied in the cylinder-head construction, namely, the turning of the working charge and imparting to it a direction of flow parallel to the power cylinder axis before discharging it through the inlet port.

The engine shown in the illustration is rated at 300 hp., and has for some time been carrying the entire shop load of the Scott Foundry Department of the Reading Iron Co. It operates on producer gas. A similar one of 500 hp. is nearing completion.

Fig. 4 is a reproduction of an indicator diagram

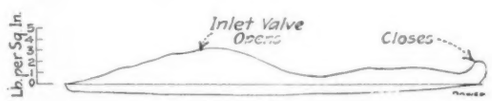


FIG. 5. INDICATOR DIAGRAM FROM PUMP

taken under operating conditions, and Fig. 5 shows an indicator diagram taken from the pump.

TEST OF ENGINE

In the following table are given the results of a 33½-hr. full-load test on this engine:

TEST OF 300 HP. ILLMER GAS ENGINE

Duration of test, hr	33½
Grade of coal	Westmoreland bituminous @ 14,100 B.t.u. per lb. as used
Character of load	Water rheostat
Average load registered on calibrated recording ammeter, amp.	774
Average voltage (corrected)	253
Average developed load, kw	196
Average developed load, B.hp.	284
Power required for auxiliaries, kw	11
Power required for auxiliaries, B.hp.	16
COAL BURNED	
Fed to hopper, lb.	10,352
Equivalent required for steam jet blower, lb.	502
Total coal used in 33½ hr., lb.	10,854
Cold cleaned gas measured in holder, feet per pound of total coal used.	65.4

ANALYSIS OF GAS

CO_2	2.91 per cent. by volume
O_2	0.2 per cent. by volume
C_2H_4	0.7 per cent. by volume
CO	27.51 per cent. by volume
H	6.52 per cent. by volume
CH_4	2.24 per cent. by volume

Average B.t.u. of gas by calorimeter (35 determinations corrected for holder temperature, and pressure) B.t.u. per ft. higher	144
Average B.t.u of gas by calorimeter (35 determinations corrected for holder temperature, and pressure) B.t.u. per ft. lower	138
Producer efficiency on basis of cold cleaned gas and total coal used, per cent. on higher B.t.u. of gas	67
Producer efficiency on basis of cold cleaned gas and total coal used, per cent. on lower B.t.u. of gas	64
Thermal efficiency of engine, lower B.t.u. per b.hp.-hr.	10,300
Total coal used per developed b.hp.-hr., lb.	1.14
Total coal used per developed kw.-hr., lb.	1.65
Total coal used per b.hp.-hr., delivered for use, lb.	1.21
Total coal used per kw.-hr., delivered for use, lb.	1.75

The instruments on which the results were obtained have been checked with the General Electric standards, and it was found that the instruments read a little low; hence the revised results are even more favorable than the original figures.

Rubbish as Fuel

Different waste materials have different heating values, the combustible value of some of them, such as shavings and turnings of wood-working establishments, spent tan bark of tanneries, etc., being so high that they are used by many manufacturing establishments as the principal fuel for generation of steam. It does not pay, however, to burn these materials or trash along with coal. The ash of the more highly combustible substances contained in the waste material becomes mixed with the coal and hinders or almost entirely prevents combustion of the coal and much of the latter is slowly coked off in incomplete combustion or drops through the grates. There is fuel economy in burning waste material exclusively, provided its combustion yields sufficient heat to keep up steam, but where the main fuel is coal, rubbish or other waste material should not be burned in a boiler furnace, excepting at the end of a run or just prior to cleaning of fires.

Even then it may not pay if the use of waste material is attended by such imperfect combustion as to produce excessive deposits of soot on the heating surfaces of the boiler, thereby reducing the efficiency of the heating surfaces and the evaporative economy when firing the coal required. The effect which waste material has on a boiler depends entirely on the character of the combustible. Highly combustible material like yellow-pine chips or shavings, by local impingement of intense flame when used as fuels, are likely to burn or blister a boiler, especially such portions of the heating surface as are not cooled by rapid circulation of water in the boiler, while waste material which contains much moisture causes a rapid rusting out of sheet-iron or sheet-steel smoke breechings, uptakes and smoke-stacks.

In addition to the objection referred to, in making use of waste material as fuel, the fact should be borne in mind that moist or wet fuels of almost any kind are more rapidly destructive of firebrick furnaces than dry fuels.

The Southwark Foundry & Machine Co., Philadelphia, Penn., is making three 3000-kw: Rateau turbine-driven alternators for the Pittsburgh Steel Co. It also recently shipped a 1500-kw. unit to the Goodyear Tire & Rubber Co., Akron, Ohio, and another unit to the Reading-Massachusts Rubber Co., all of the mixed-flow type. The company has also built five turbo-driven rotary blowers, of which three are in operation. These have a maximum capacity of 50,000 cu.ft. of free air per minute, and a maximum blast of 30 lb.

REFRIGERATION DEPARTMENT

Cooling Tower for Small Refrigerating Plant

By R. L. Mossman

The accompanying drawings illustrate a cooling tower built by the writer for cooling the water from the ammonia condenser in a small refrigerating plant of 8- to 10-ton capacity. The condenser is of the double-pipe type, with 1¼- and 2-in. pipes, 19 ft. long and 12 pipes high. The tower consists of four stands of 20 strips each, the strips being 1½ in. square, rounded on top and 16 ft. long. They are spaced on 5-in. centers and supported by notched pieces of 2x4-in. timbers, as shown in the drawings. Fig. 2 is a detail drawing of the trough and strips. The trough, which is supported by the 2x4-in. uprights, distributes the water at the top of each stand.

The tower rests on a floor of tongue and grooved boards supported by 2x12-in. joists and a frame of 6x6-in. timbers, as shown in Fig. 1. The floor slopes toward the trough, the drop being about 3 in., and the trough itself slopes toward the tank, as shown in Fig. 1. A piece of 1½-in. pipe is secured to the bottom of the trough with locknuts and discharges to the tank. The suction to the circulating pump is connected to the bottom of the tank and the warm water from the condenser is piped to the troughs on top of the tower. It may be noticed in Fig. 1 that the tank is equipped with a float valve controlling the city water supply. Due to evaporation and other losses some make-up water is required.

The tower was built without the louver around it, but in high winds there was considerable loss of water, and the louver shown in the drawings was added. Contrary to the usual custom the slats are turned up to catch and drain back any water which may be thrown against them.

With a temperature of the atmosphere of 65 deg., the humidity not being known, water supplied to the tower at 80 deg. F. was returned at 65 deg.; about 19 or 20 gal. of water was circulated per minute. The high-pressure ammonia gage showed 150 to 155 lb. The compressor was a 6½x6½-in. double-cylinder, single-acting, vertical machine running at 150 r.p.m.

The writer knows of a tower of this type with strips 16 ft. long and 20 strips high with but two stands. This gave a total of 640 linear feet of strips which were claimed to cool the water for an 8-ton plant from 100 to 80 or 85 deg. In my opinion three stands would be sufficient for an 8- or 10-ton machine.

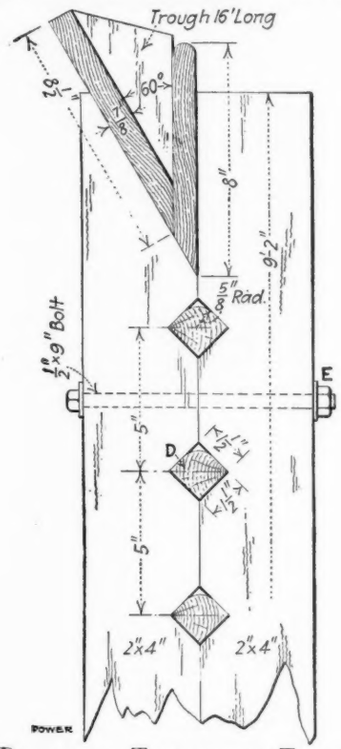


Fig. 2. Details of Trough and Top of Stand

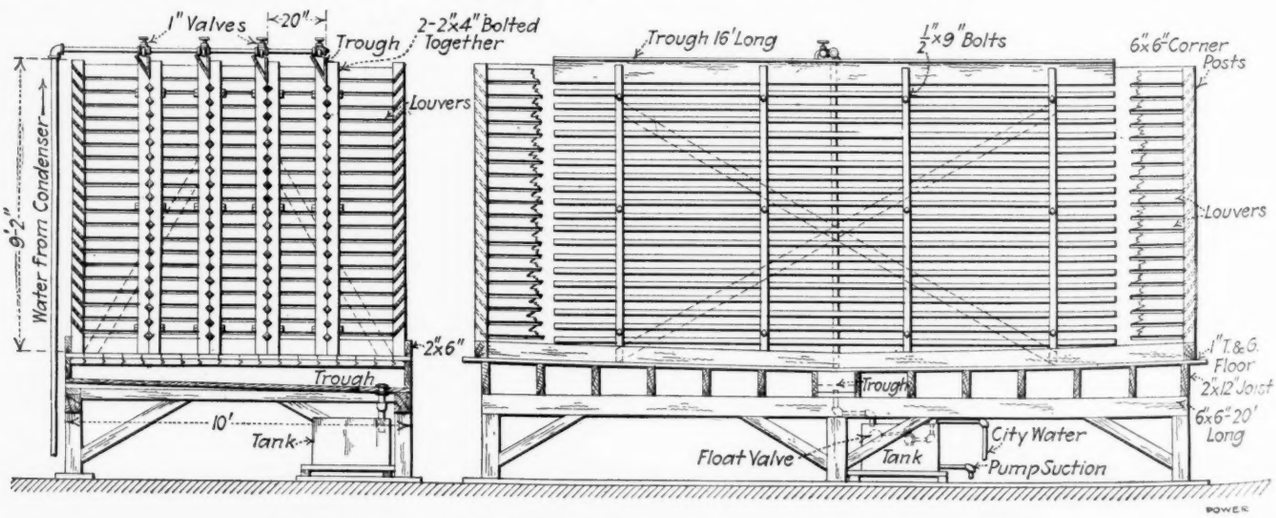


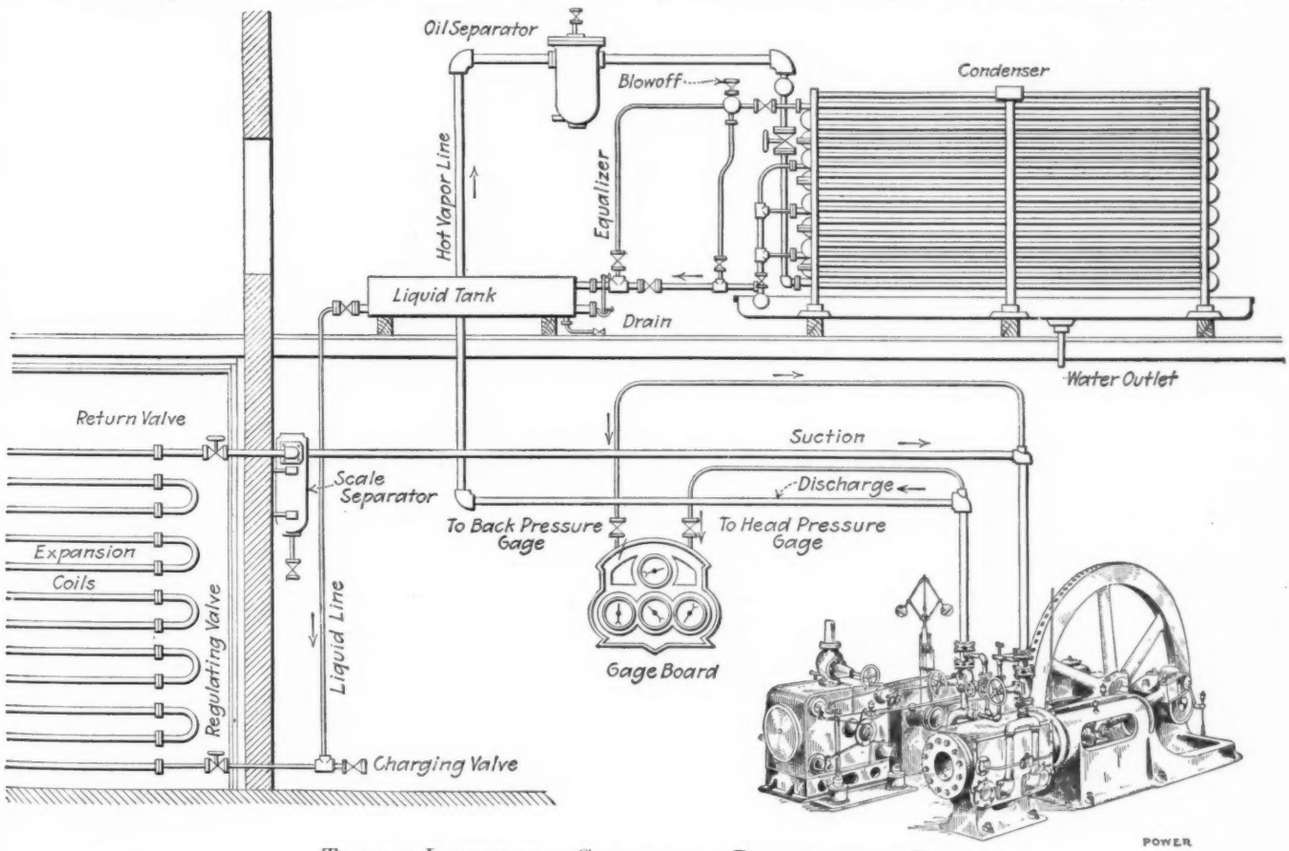
Fig. 1. Transverse Section through Tower and Side Elevation

The Compression System

In the Mar. 11 number of POWER an elementary description of the ammonia-compression system was given and a simple diagram showed how refrigeration was accomplished. The four fundamental parts of a compression plant and their relation to each other were shown in diagrammatic form. As will be remembered, these fundamentals were a compressor to draw the cold vapor from the expansion coils, compress it to a high pressure and discharge it; the condenser where the high-pressure vapor from the compressor is liquified; the regulating valve (more commonly but erroneously called the expansion valve) which reduces the pressure of the liquid from the condenser, and the expansion coils in which the liquid is changed into a vapor by absorbing heat from the room or brine tank in which the coils are located. In one form or another these four sections are always present and to these are usually added a number of auxiliaries, such as a liquid tank, to receive the ammonia from the condenser, scale and oil separators, pumps for forcing the oil to the cylinder or perhaps the bearings, and a couple of gages to show the pressures in the suction and discharge lines of the compressor.

Naturally there is considerable difference in the construction of the different apparatus employed. The compressor may be horizontal or vertical, single-acting like the usual small gas engine or double-acting like the steam engine. The condenser may consist of a series of pipes or coils submerged in water, it may be of the atmospheric type in which the pipes are exposed to the air with a thin stream of water trickling down over their surface, or a double-pipe counter-current condenser in which the ammonia in the inner pipe flows in a direction opposite to the water in the outer pipe may be used. There are different kinds of regulating valves and the arrangement of the expansion coils may vary.

It is not necessary to use a particular type of condenser with a certain design of compressor. Each has its own work to perform, and its efficiency does not depend primarily on the other. The same is true in a power plant. The boiler may be of the fire-tube or water-tube type and if steam of the proper quality and pressure is supplied the engine, its economy will not be effected. As long as there is plenty of surface for the conduction of heat in the refrigerator and condenser, pipes of sufficient size for the vapor to pass without friction and an easy passage for the liquid ammonia, types do not count. The accompanying illustration, then, may be used to show the general requirements of a commercial plant. The high-pressure end of the system, consisting mainly of the compressor and condenser, is shown in full detail, but the low-pressure side (expansion coils) is merely indicated, as there will be some variation in every installation.



TYPICAL LAYOUT OF A COMPRESSION REFRIGERATING PLANT

We will begin with the liquid ammonia which is stored in the liquid tank. In the drawing the tank is shown on the same floor as the condenser, but just as often it is located in the engine room, and in this case it is usually a vertical tank. The liquid in this tank is under the same pressure as the condenser (135 to 200 lb., depending on the temperature of the cooling water). When the regulating valve is opened the high-pressure liquid flows into the expansion coils in the amount required to maintain the desired temperature. This is, of course, controlled by the number of turns the valve is opened. If the temperature in the coils is below 32 deg. F., and it

usually is, some of the moisture in the air will be condensed and accumulate in the form of white frost on the piping. This interferes to some extent with the absorption of heat from the room, but enough gets through the coating of frost and the walls of the piping to evaporate the ammonia just as steam is made from the water in a boiler when heat above the boiling point is applied. Each pound of the liquid ammonia at the above pressure requires 569 heat units to change it into a vapor. The temperature of the liquid ammonia, however, as it comes from the liquid tank, must be reduced to a temperature corresponding to the lower pressure in the refrigerator, which is usually about 16 lb. gage. This heat then evaporates part of the ammonia, and less than 500 heat units need be absorbed from the room, and whatever this figure, it represents the actual amount of refrigeration available per pound of the liquid fed to the expansion coils.

From the expansion coils the vapor passes through a scale separator, which removes any scale or foreign matter which might injure the compressor as the vapor is now in the suction line. When in the cylinder, it is compressed and is forced through the hot gas line to a pressure tank, if one is employed. In its passage from the head of the tank to the interior it is given a spiral motion to cast out any oil that may have been carried over from the compressor. In some cases this tank is omitted and simply an oil separator installed in the line to the condenser. The vapor then passes through a check valve and enters a header connected to the bottom pipes of the several stands of the condenser. It may be noticed that the hot vapor line rises higher than the condenser, so that none of the liquid it contains can return to the compressor when it is shut down. The condenser is of the atmospheric type with water trickling down from above over the coils of pipe. Before the vapor reaches the top pipe of the condenser practically all of it has been reduced to a liquid, and as fast as this liquid is formed it is drained through small pipes connected from different levels to a liquid header, which discharges to the liquid tank. In case any of the vapor is carried along with the liquid it may escape to the top of the condenser through the equalizer line. It will be noticed that the liquid tank is provided with a drain and close to the entry into the expansion coils a charging valve is provided. Through this valve the system is supplied with liquid ammonia from the shipping drums.

We are now back to the starting point and there is no need for further description, the operation just described is repeated over and over again. The type of apparatus employed may be different, but the general working will be the same and the foregoing outline of the cycle of operation will apply to all types of ammonia-compression plants.

Temperature of Storage Rooms

The following question and answer may be of general interest as the same trouble has, no doubt, been encountered in other plants:

Some angle-type thermometers had been purchased and placed in cold-storage rooms so that the temperature inside of each room could be seen on the thermometer from the outside. The thermometers were placed in the walls first as shown in Fig. 1, and then as shown in Fig. 2, but in each case the reading was 5 deg. higher than a reading taken inside the room. The thermometers were tested and found to be accurate. The walls were 6 in. thick and were lined with cotton-seed husks.

It is rather difficult to place an angle thermometer in the walls of a cold-storage room so that it will register the average temperature of the room. In most cases the temperature near the walls is either higher or lower than the temperature in the center of the room. It is lower when some refrigerating piping is located on the wall on which the thermometer is placed and it is generally higher if there is no piping on the wall. In the former case there is a current of cold air flowing down from the coils over the thermometer bulb and in the latter case warm air rises along the wall to the cooling coils wherever they may be placed.

It is desirable to locate a point on the wall where the temperature taken by an ordinary cold-storage thermometer corresponds to the temperature reading at the center of the room. If no such location can be found it will be absolutely impossible to locate the angle thermometer for a correct reading. In such a case, it is possible, of course,

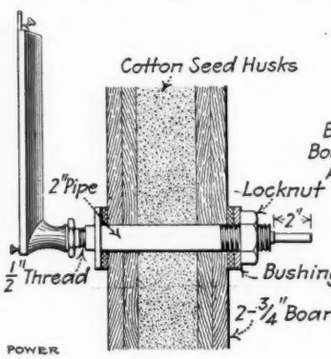


FIG. 1.

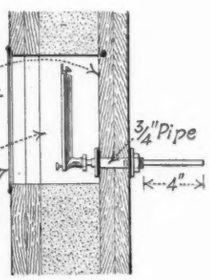


FIG. 2.

to find out how much higher or lower the angle thermometer reads than a thermometer placed in the center of the room, and correct the reading accordingly.

On account of the difference in the air currents, it will be found that the temperature in various parts of any cold-storage room will vary considerably, depending not only on the quality of the insulation, but also on the distribution of the cooling pipes and the location of the various walls of the room with reference to the outer air.

Referring to the sketches it would not be advisable to pass the pipe thimble all of the way through the insulation, or even part of the way for the reason that this thimble will transmit heat from the outer air to the thermometer bulb, and consequently influence the reading.

It would be better to install the thermometer so that the only metal attachment is at the outer side of the cold storage room, while the hole through which the thermometer passes should be filled with insulating material so that there will be no possibility of heat being transmitted to the thermometer bulb from the outside.

As an example of the way in which steam engineering is sometimes done, attention is called to a "call for bids" recently issued by a Western city, which specifies:

One 50-hp. Horizontal Steam Flue Boiler with dome, 150 lb. working pressure, size 48 in. by 14 ft., full front, grates and grate bars, pop safety valve 2½ in., also one 2½-in. extra heavy blowoff valve with wheel.

EDITORIALS

Mixed-Pressure Steam Turbines

In engineering, as in other phases of industrial progress, what is here today is gone tomorrow, and the things of tomorrow are not known. Crude, indeed, would appear the old pumping engines of Newcomen's and Watt's time. The old haystack boilers would also equal them as relics of the olden steam-engineering days. The old slide-valve engine, with its round-rimmed flywheel, and in some instances wooden eccentric rod, would look sadly out of place today; and yet they were all models in their time. Progress has left these old times far behind.

Times have changed; engineers are looking for prime units which will produce the greatest output with the least steam consumption. Because of this constant straining after greater economy, the Corliss engine, various types of four-valve engines and single-valve automatic engines have been designed, and have filled their place in the power plant. In many of the larger power stations, the high-pressure steam turbine, using superheated steam, has supplanted the reciprocating engine, and in other instances the exhaust-steam turbine has been installed to operate in conjunction with the reciprocating engine. Each type of prime mover has represented an advancement in steam engineering, and has probably met all expectations as regards efficiency and economy in operation.

These units all have a place in the power plant, but the turbine is not as efficient as the reciprocating engine when running noncondensing or on a low vacuum. The low-pressure turbine is useless unless the reciprocating unit, to which it is piped, is in operation, because the steam necessary to operate it must come from the engine.

There are times when the load to be carried is not sufficient to give the reciprocating engine an economical steam consumption. To operate the engine under such conditions is a waste of fuel. The exhaust-steam turbine is useless, because it would be folly to operate it in conjunction with the already underloaded engine.

This underload condition has confronted the engineer and power user for years. As a means of obtaining economical operation a small steam unit has generally been installed, so that when the load for the large unit becomes uneconomical, the small unit is started and carries it. When the load is sufficient to warrant the operation of both large and small reciprocating units, fairly good operating conditions exist, but both units are operating with live steam and generally the exhaust steam from both units is discharged to the atmosphere; a loss that can be eliminated in many installations.

It is in such instances that the mixed-pressure steam turbine comes into the field and fills a place in the economic operation of the plant that was not dreamed of a few years ago. With this type of turbine the reciprocating unit furnishes the low-pressure steam during the period it is in operation and the exhaust steam, as in the case of the exhaust-steam turbine, is utilized in doing useful work. But unlike the ordinary exhaust-steam turbine, when the main reciprocating engine is shut down, the mixed-steam turbine is still a useful unit, because it is capable of operating with live steam from the boilers.

If there are pumps exhausting to the atmosphere, this steam can be piped to the turbine and made to produce energy instead of being wasted. Running at night, when the load is light and the main unit is shut down, is a condition suitable for this class of turbine. In the morning when the large reciprocating engine is started up, the turbine can be changed back to exhaust steam without a moment's delay, and the generator of both units operated in parallel.

The mixed-steam turbine can be run with low-pressure steam entirely, with a partial supply of exhaust and high-pressure steam, and with high-pressure steam alone. This makes a combination capable of meeting the requirements of most steam plants in which this type of turbine can be utilized.

Of course, the condenser outfit must be added to the installation cost of the turbine, because it is necessary for the operation of the turbine. But for all that, the arrangement is eminently capable of increasing the economy of operation of the reciprocating plant, where conditions warrant its installation.

The Oil-Fuel Problem

The statement that crude oil will no longer be offered for sale by a certain important oil company, a company that has considerable influence on the oil market, has been made authentically. The obvious reason is the greater profit from the sale of the byproducts of petroleum. Naturally, this policy, if carried out, will seriously affect the cost of power production in a great many plants and the possibility of such a situation deserves the careful thought and study of all classes of manufacturers and power-house operators.

The oil deposits of the country are far from being exhausted—many of the large oil fields still remaining practically untouched—and the cost of sinking wells, transporting the oil, etc., are not much greater today than ten years ago. During this time, however, the demand for gasoline has increased tremendously, it is true, and, of recent years, the wide introduction of fuel-oil engines has created an increased market for crude and the heavier oils.

The increased demand for gasoline would naturally explain the elevated price of that commodity, a natural result, if the demand has increased more than twice as rapidly as the supply—more than twice as rapidly, for the price of commercial gasoline has nearly doubled during the past ten years, while at the same time its quality has steadily declined. That is, gasoline as procurable today is no longer as pure as it was formerly, but contains a quantity of benzolene and probably a considerable proportion of the more stable benzines or

naphthas. In other words, the "gasoline" obtained from a given quantity of crude oil is five to eight times as much as formerly. The market price having nearly doubled, the gasoline value of petroleum would appear to be ten to fifteen times as great as in the days when commercial gasoline was of a higher grade, for the cost of distillation remains comparatively the same—any increase being considerably under one hundred per cent. In addition, there is another relatively recent source of income from the distillation of crude oil; liquid distillate, the fuel secured by passing certain of the lighter distillate gases—gases driven off before the more stable gasoline in refining crude oil—through water. The fuel thus obtained has a power-generating value, in stationary engines at least, that is very nearly as great as that of the present commercial gasoline and which sells for but a slightly lower figure.

Crude oil has recently been selling at a price that is fully three times as great as that at which the same commodity was sold within recent years and, though this may be explained in a measure by the increased demand for gasoline, the same argument or excuse cannot be advanced for the present high price of fuel oil. Fuel oil is not necessarily crude oil. In fact, an excellent fuel oil, and the oil generally sold as "fuel oil," is the residue after the gasoline has been distilled from the crude. With the gasoline value of crude oil probably ten to fifteen times as great as formerly and the added income from liquid distillate, it would seem that the price of fuel oil should not have increased to such an extent, even if crude does sell for three times the amount it formerly commanded. In the past, fuel oil sold for less than the price demanded for crude oil. Today the price for fuel oil is not much less than that for crude oil, else there would not be the demand for crude oil for power purposes. The really phenomenal growth in oil-engine installations that would be necessary to create such a demand for fuel oil as to justify the present price of that commodity is not apparent, neither is the increased market for the heavier byproducts of petroleum much greater than the increased supply of crude oil. The oil industry would appear, therefore, to have been rather an unprofitable one in the past in order to justify the present market prices of crude oil, gasoline and fuel oil.

❖

What the Tenants Pay

Engineers have wondered why owners of office buildings and large apartment houses purchase central-station current instead of putting in an isolated plant to serve the tenants. Occupants of such buildings are charged enough for electrical energy to make a neat profit for the central station. Why should not the same class of customer be attractive to the isolated-plant owner?

The average rate paid by tenants of apartment houses and office buildings, unless lighting is included in the rent, is ten cents per kilowatt-hour, but the central station does not get this rate, although it is charged in the bills rendered. As a matter of fact, the owner of the building or landlord pays the central station about four and a half cents for the same current and pockets the difference as his profit on an investment of nothing.

This practice, which obtains in New York and undoubtedly in many other cities, makes it clear why more isolated plants are not found in such buildings. There is no incentive to put in machinery to generate private electrical energy, when about fifty per cent. of each tenant's lighting bill goes into the landlord's pocket. This profit is not interest on an investment, it does not represent income from a legitimate business, but it does represent a form of graft that should be stopped.

If the central station can and does sell current to the landlord for about four and half cents per kilowatt-hour it is a clear case of robbery to charge the tenant ten cents for the very same current. This situation in New York, we understand, is being investigated by the Public Service Commission. It is to be hoped that the commission will put a stop to the holdup.

❖

Time for Repairs

Now that the heating season is at an end, the time is appropriate to begin repairs. Another month will bring with it hotter weather and this will lessen the ambition to get at the jobs in nooks and corners that require attention. The leaks and defects that were the source of so much trouble the past winter, might require but little work to right, and if done now, while the memory is fresh, it will mean fewer burns and better service when it is again time for the system to be used.

If there are traps be sure that they are clean and in good working order. If trouble has been experienced in heating the distant points, perhaps a larger or more direct line would give better satisfaction. If it would, do not wait until the last few weeks of summer before making the changes. With a vacuum system it is important to examine the valves and packing of the pump. Do not leave it in a condition that might cause trouble at a critical moment. Remember that there is a steam end and valve gear that require attention. In short, see that the system is in condition to give first-class service when the season opens.

❖

How would you like to be—no, not the iceman—the chief boiler inspector of Allegheny County, Penn.? He gets three dollars for every boiler inspected and, by law, every boiler in the county must be inspected annually. From Aug. 6, 1912, to Feb. 5, 1913, his staff inspected 3542 boilers—a rate of over seven thousand boilers a year. Then the income of the office cannot be under twenty-one thousand dollars, although it is claimed never to have reached twenty-five thousand dollars. Out of this sum the chief inspector pays office rent and the salaries of five inspectors, a bookkeeper and a clerk. Now if you were the chief inspector, do you think you could worry along on what he has left?

❖

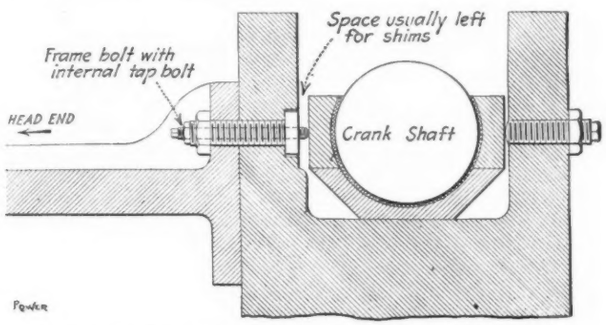
Governor Sulzer, of New York State, has signed the Jackson bill which seeks to give greater protection to the employees of factories. If it is of concern to the state to protect operatives in the industries by providing safety devices on machinery and taking precautions against death and sickness from occupational diseases, it should be its concern to guard the public as well from injury due to boiler explosions. As the legislature has just passed the Jackson bill it indicates that its present membership is kindly disposed toward humanitarian measures which gives reason to hope that the Willmott bill on boiler inspection may receive favorable consideration.

READERS WITH SOMETHING TO SAY

Recommends New Feature in Pillow-Block Design

In nearly all horizontal engines the crank pillar is bolted on to the engine frame. The quarter boxes are adjusted at the head end with liners and, on the opposite side, tap bolts are used with jam nuts on them.

It would be a good idea to so design the position of the two top frame bolts that a center line through them would also come in the center of the head-end quarter box, as shown. The bolts could be made larger in diameter and a hole drilled through their center and tapped out. Into this hole a tap bolt could be screwed and by this means the bearing could be adjusted to the journal, as indicated by the illustration.



PILLOW-BLOCK BRASSES ADJUSTABLE FROM HEAD AND CRANK ENDS

At present, with these engines, if there is not time to take the bearing apart, the knock or pound is overcome by screwing up on the two crank-end tap bolts; this throws the main shaft out of line as the quarter boxes usually wear equally. By means of the frame bolts being fitted with internal tap bolts, the wear could be taken up equally.

J. A. CAMPBELL.

Providence, R. I.

Two Engine Wrecks

The engine in the plant of the American Laundry, Flanders St., this city (Portland, Ore.), was wrecked recently. The engine was a medium-speed automatic-balanced slide-valve type of about 60 hp., belted to the line shaft and had been in use about four years.

The disk gave way as the piston was on the forward stroke. The momentum of the flywheel together with that of the line shaft carried the crankshaft over the center, opening the valve for the return stroke which drove the piston against the head, forcing it off the rod, bending the rod and breaking the main frame and cracking the cylinder. The piston, cylinder head and part of the cylinder were carried about four feet, striking an 8x8-in. post that supported a large heater. The post was moved several inches.

Steam was at once shut off at the boilers and no one was injured. No blame was given the engineer in charge as an examination showed that the crank disk had been cracked, presumably by too tight a fit of the crankpin when the engine was built. A new engine of the same class was at once secured, a force of mechanics put to work and the plant was ready to run the next morning.

A 9x14-in. high-speed automatic center-crank engine belted to two dynamos in the mill of the Standard Box & Lumber Co., Portland, Ore., was wrecked a short time ago. The piston rings were in three sections set out by springs. Each section was made up of three pieces riveted together. The rivets in one section sheared, allowing a part of the ring to drop. It caught on the counter bore, and at the commencement of the stroke the cylinder was split. As the cylinder and frame were one piece a complete new frame had to be ordered from the East. No one was hurt and the property loss was confined to the engine.

C. F. KING.

Portland, Ore.

Unusual Experience with Pump

Instructions were received to examine a duplex pump, the owners having reported that the pressure gage greatly fluctuated and that the water column in the discharge pipe was very unsteady. On arrival at the pump house, I found that the pump was driven by a horizontal Corliss engine and that it was running when I arrived.

I found things just as reported—the pressure gage very unsteady, owing to surging of the water in the discharge pipe. This surging was very noticeable when one stood on the ground which covered the discharge pipe outside of the building.

I listened, with my ear close to all four corners of the pump, thinking that some of the valves were missing or leaking badly, but I could not detect any trouble and to look and listen in the pump house everything seemed to be running satisfactorily; so it seemed to me that there might be some high spots in the discharge pipe between the pump and the reservoir, but the engineer assured me that there was a small relief cock at all the known high places and that these cocks were leaking water so that I need not look for air pockets in the discharge pipe.

The pump had no suction lift, as the water flowed from a tank to the pump. The water level in the tank would bring the water about one foot above the top of the pump delivery-valve chamber. There was no check valve between the pump and the discharge pipe; there was a gate valve on the discharge pipe close to the pump.

I noticed that one corner of the pump looked lighter in color than the other three corners, so I at once put my hand on this corner and found the casting perfectly dry while the other three were quite moist to the hand. One

corner of the pump was air-bound. Hence, the reason it was dry. The plungers were outside packed and each plunger chamber had a handhole on the side. With the pump still running, I slacked off the nuts on the handhole plate about 1/8 in. and wedged it off until the water came out. This released the air and the trouble was over.

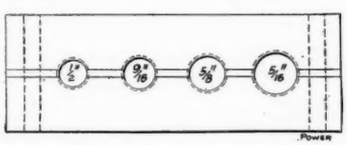
To prevent any such trouble in the future, I drilled a hole for a 1/4-in. pipe under the discharge valves of each corner and put in a 1/4-in. globe and check valve. Water or air could not blow out of the check valve; but if the water in the tank was low, the check would close on the suction stroke. When certain that the air was out, the globe valves were closed.

JOHN ASHFIELD.

Oakland, Calif.

Holder for Threading Stud-Bolts

The engineer is often called to make stud-bolts, and if the proper tools are not at hand it is a difficult thing to do so. It will be quite easily accomplished if one will take two pieces of machine steel, 1 in. square and about 6 in. long and place them side by side with a 1/8-in. strip between them and clamp them tightly together. Now drill and tap four or more holes, say, 3/4, 5/8, 9/16 and 1/2 in., as indicated in the sketch, and after doing this remove the clamp and discard the thin strip. Now drill a hole at each end at right angles to the tapped ones, say, 5/16 in., for a bolt to hold the two pieces together. Now insert a



HOLDER FOR THREADING STUDS

stud in the size hole corresponding to the thread in the two pieces and clamp the two pieces together with the bolts at each end. The holder being held firmly in a vise will enable one to close-thread the stud.

The same thing can be accomplished by sawing a nut (of the size stud used) in two and placing the two halves over the threaded end of the stud and clamping them in the jaws of the vise.

J. L. HARPOLE.

Hopkinsville, Ky.

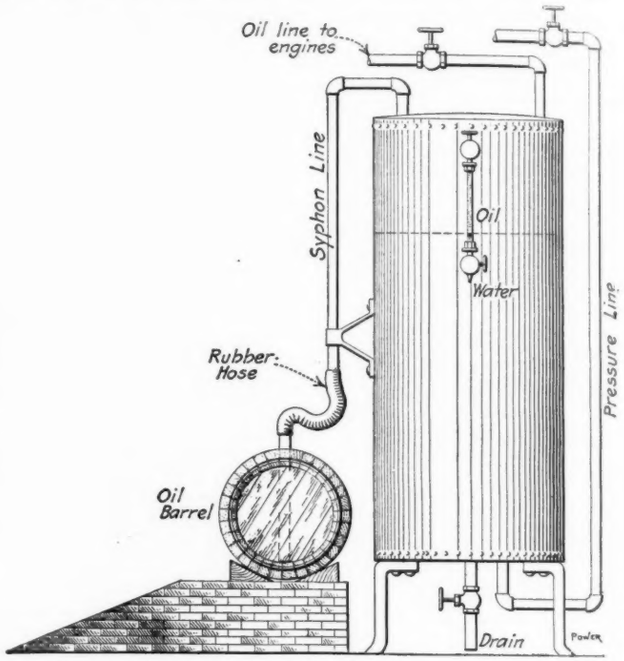
Siphon Oil-Barrel Emptier

After trying a number of methods for emptying barrels of oil directly into the oil reservoir, we have at last got one which seems to excel all others for simplicity and ease of operation. The sketch gives an idea of this emptier and filler.

The large reservoir is made of heavy sheet iron and is capable of holding a couple of barrels or more. It stands full of water, or oil and water, as the case may be. The pipe line entering it at the top and bottom, respectively, are for the delivery of oil to the engines, pumps, etc., and, as we use steam pressure, for the reception of the condensate from the steam line. Another line, with a valve, connects the top of the tank with the oil barrel.

The principle used in conveying the oil to the tank is that of the siphon. The barrel is rolled to a point of elevation above the discharge of the drain in the bottom of the tank.

After closing the valves on the lines where pressure is maintained, and with the oil tank nearly full of water, the drain-line valve is opened to relieve the pressure in the tank. The valve in the siphon line is then opened and the weight of the atmosphere forces the oil from the



SIPHON-BARREL EMPTIER READY FOR SERVICE

barrel into the tank where a partial vacuum is formed by the water gravitating from the tank. The drain must be promptly closed when the barrel is empty or the contents of the tank will be lost.

EDWARD T. BINNS.

Philadelphia, Penn.

Piston Rod Breaks Third Time

On Mar. 22 occurred the third accident to our small high-speed engine within 13 months.

The piston rod broke off in the crosshead and knocked out the cylinder head, which hit an iron door that, when swung back, is directly in front of the engine cylinder. There was a large hole knocked in the brick wall.

The cylinder-head bolts were all broken off and the stuffing-box nut and the oil plate between the guides and cylinder were broken.

The rod through the stuffing-box was 1 7/8 in. in diameter and was tapered down to 1 11/16 at the crosshead before the threads were cut, and was 1 35/64 in. in diameter at the bottom of the thread. According to my calculations these dimensions do not figure out correctly for 100 lb. pressure, being too small. We had the crosshead bored out and the rod made the same diameter the entire length. This engine has been in service for about eight years, and so far as I know has never given any trouble.

Fortunately, no one has been hurt in these accidents, but we have taken the pains to fence in the engine so one cannot walk in front of the cylinder.

G. W. HUBBARD.

Cherokee, Iowa.

Whistling Pump

A deep-well pump, the 4-in. discharge pipe of which was hung about 3 ft. below the engine-room floor was part of our equipment. The pump discharged into a cistern about 20 ft. from the pump. A ½-in. pipe was tapped into the 4-in. pipe and was once used for a drain from the steam cylinder. When its use was discontinued the ½-in. pipe was left projecting about 1 in. above the floor line. The pump operated in this manner for several years without making any unusual noises, when rather suddenly there occurred with every up stroke of the pump a very perceptible whistling noise, as though the rod or cylinder were dry. Oil and graphite liberally applied did not stop the noise. The mysterious noise worried the engineer for several days, but while looking for the trouble, he accidentally covered the end of the ½-in. pipe with his foot and the noise stopped at once. Upon investigating, it was found that with each up stroke of the pump air would whistle up through this pipe caused by the water that was discharged into the 4-in. pipe.

GAY A. ROBERTSON.

Louisville, Ky.

Interesting Indicator Diagrams

It would interest me and perhaps others to have readers comment on the accompanying indicator diagrams, Figs. 1 to 9, taken from compound condensing marine engines and pumps. Both the port and starboard main engines and pumping engines have piston valves for the high-pressure sides. The main engines have the Allen slide valve on the low-pressure side, and the pumping engines have the common D-slide valve on the low-pressure side.

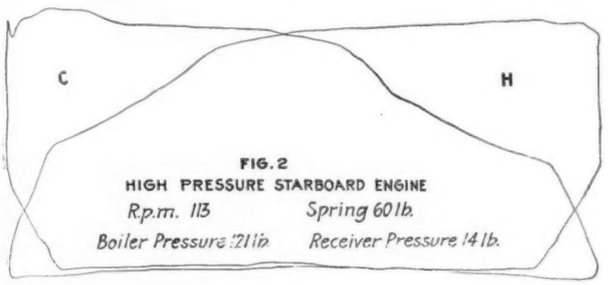


FIG. 2
HIGH PRESSURE STARBOARD ENGINE
R.p.m. 113 Spring 60 lb.
Boiler Pressure 121 lb. Receiver Pressure 14 lb.

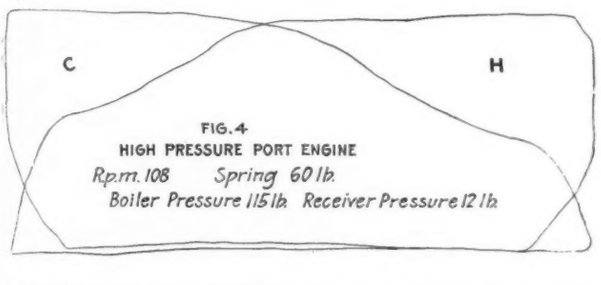


FIG. 4
HIGH PRESSURE PORT ENGINE
R.p.m. 108 Spring 60 lb.
Boiler Pressure 115 lb. Receiver Pressure 12 lb.

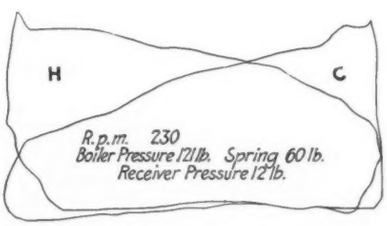


FIG. 6
HIGH PRESSURE PORT PUMP

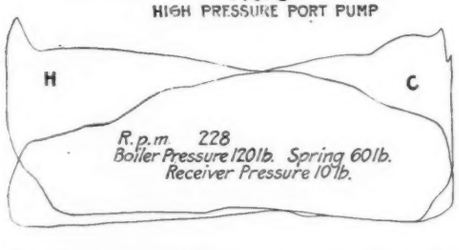


FIG. 8 - HIGH PRESSURE STARBOARD PUMP

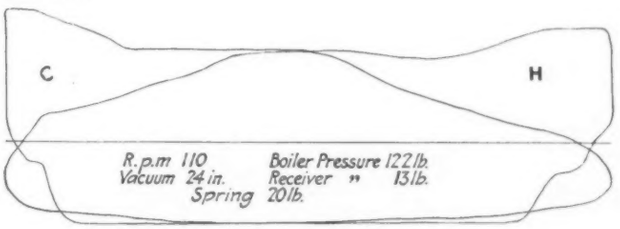


FIG. 3 - LOW PRESSURE STARBOARD ENGINE

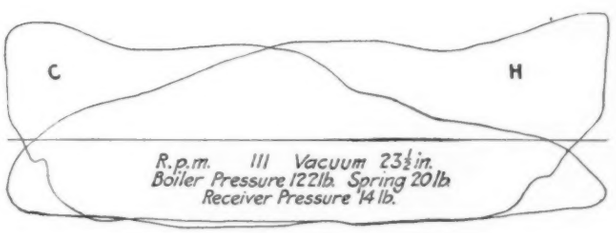


FIG. 5 - LOW PRESSURE PORT ENGINE

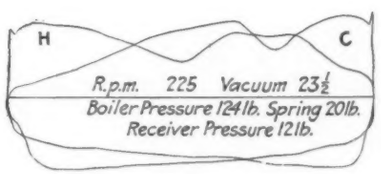


FIG. 7 - LOW PRESSURE PORT PUMP

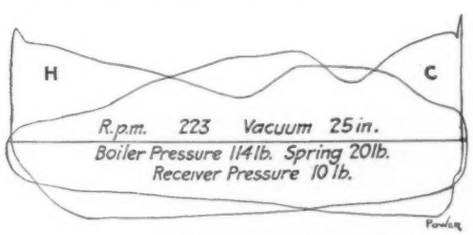


FIG. 9 - LOW PRESSURE STARBOARD PUMP

DIAGRAMS FROM COMPOUND CONDENSING ENGINES

The receivers of the pumping engine are of cast iron running from end to end. This type of receiver is, I believe, the cause of the hump in the steam line of the diagrams from the low-pressure side of the pumps. The main engines are each of 30 and 15 by 12 in.; the pumping engines are each 22 and 12 by 14 in.

Savannah, Ga. OTTO RICHTER.

QUESTIONS BEFORE THE HOUSE

Factor of Evaporation

A. L. Westcott's letter, in the Apr. 1 issue, commenting on A. A. Potter's, "Factor of Evaporation," in the Mar. 11 issue, was read with interest. This is a somewhat confused subject. The equivalent evaporation is determined from the actual evaporation and is equal to the actual evaporation times the ratio of heat content of one pound of steam above feed-water temperature under actual conditions to the heat required to vaporize one pound of water from and at 212 deg. F.

This computation may be made in either one or two steps. The items quoted by Mr. Westcott from the A. S. M. E. code are correct, but are somewhat ambiguous in their statement. Item 59 reads: "Water actually evaporated, corrected for quality of steam." If Mr. Westcott will look up App. xviii and xix to the code, he will find that this item is not, water fed to the boiler times the quality of steam, where the quality is one minus the decimal representing moisture, but the water fed to the boiler times a factor of correction determined from the quality, as shown below. This item 59 is the weight of water which would have been evaporated had the steam been dry and saturated, with the same heat input under existing conditions of feed temperature and steam pressure. The equivalent evaporation is then found by multiplying item 59 by the factor of evaporation for dry steam. That is, item 61 = item 59 × item 60 = items 57 × factor of correction and item 60.

But this item by definition is also equal to item 57 times the actual factor of evaporation where the actual factor of evaporation is the ratio above mentioned. We can write from the above,

actual factor of evap. = *factor of correction* × *item 60*

or factor of correction =

$$\frac{\textit{Actual factor of evaporation}}{\textit{factor of evaporation for dry steam}}$$

But we may write

$$\text{Actual factor of evaporation} = \frac{xr + q - q^o}{970.4}$$

$$\text{Factor of evaporation, dry steam} = \frac{r + q - q^o}{970.4}$$

Where

x is the quality of steam (minus decimal representing moisture content);

r is latent heat of vaporization at actual pressure;

q is heat of liquid at temperature corresponding to steam pressure;

q^o is the heat of the liquid at feed temperature.

We may then write

$$\textit{Factor of correction} = \frac{xr + q - q^o}{r + q - q^o} =$$

$$\frac{xr + xq - xq^o + (1 - x)(q - q^o)}{r + q - q^o} = x + \frac{(1 - x)(q - q^o)}{r + q - q^o}$$

$$= \textit{quality} + \frac{\textit{heat in moisture}}{(\textit{total heat per pound dry steam above feed temperature})}$$

Taking the example, as cited by Mr. Westcott, and computing the evaporation by the two different methods we have

Water fed to boiler per hour	=	5000 lb.
Absolute steam pressure	=	150 lb. per sq.in.
Per cent. moisture in steam	=	3
Feed-water temperature	=	130 deg. F.

1. Actual factor of evaporation =

$$\frac{0.97 \times 863.2 + 330.2 - 97.89}{970.4} = 1.102$$

Equivalent evaporation =

$$1.102 \times 5000 = 5510 \textit{ lb. per hr.}$$

2. Factor of correction for quality =

$$0.97 + \frac{0.03\ (330.2 - 97.89)}{863.2 + 330.2 - 97.89} = 0.9764$$

The water actually evaporated corrected for quality would be

$$5000 \times 0.9764 = 4882 \textit{ lb.}$$

Factor of evaporation, dry steam =

$$\frac{863.2 - 330.2 - 97.89}{970.4} = 1.129$$

and equivalent evaporation =

$$4882 \times 1.129 = 5510 \textit{ lb. per hr.}$$

which is the same as by the previous method.

The first method is much to be preferred, for not only is it simpler, but the second method is ambiguous, as the quality is frequently used in computations instead of the factor of correction.

It is true that such a method might be advocated on the ground that the heat in the moisture contained in the steam should not be credited to the boiler as it is of no value to the engine. There are numerous arguments pro and con on this question, but the general consensus of opinion seems to be that the boiler should be considered only as a heat absorber and as such should receive all credit for heat contained in the steam, including the moisture content.

L. C. Roberts.

Milwaukee, Wis.

Wavy Suction Lines on Indicator Diagrams

The wavy suction lines shown on the indicator diagrams submitted by J. E. Reynolds in Power of Apr. 8, may be due to the absence of an air chamber on the suction line, or, if one is provided, it may be located too far from the pump to be effective. Assuming that an air chamber of correct proportions is installed close to the pump, the absence of air in it would tend to produce the conditions indicated, in that no shock-absorbing medium, necessary to absorb and steady the fluctuations, caused by

the high velocity and reversal of flow of the water at this point of the stroke, is present.

I would suggest that Mr. Reynolds equip this air chamber with a water glass to ascertain whether or not any air remains in the chamber, and if not, that he open the pet-cock at the bottom of the glass until air fills the chamber about two-thirds full, and then take some indicator diagrams.

If the condition presented is accompanied by a slam of the water valves and a jump of the plunger at the beginning of the suction stroke and the same cannot be eliminated by use of the across exhaust or cushion valves, preferably the latter, I would recommend that he connect a ½-in. pipe from the top of the suction-air chamber to the vacuum pump or condenser to remove the air and hold the water up above the center of the plungers. After the air has been removed it can be kept out and the water held up with a valve in this ½-in. line only slightly opened.

W. Oliver.

Racine, Wis.

In Massachusetts

In the Mar. 11 issue I read with interest the editorial on the Massachusetts license law. Although correct, inso far as the local papers have stated it, there are some things which do not appear according to law.

Any man in this state holding a second-class license may have charge of and operate an engine or engines, no one of which exceeds 150 hp., or may operate a first-class plant. If a plant contains an engine over 150 hp., it is a first-class plant. Not many years ago a person who could qualify could receive a special license to have charge of any plant, but the law has been changed so that now no special license will be granted to have charge of a plant other than a second-class one.

As long as a plant remains the same, a man who received a special license to have charge of a plant under the old law can continue to do so at the present time, but if new engines are installed his license becomes useless.

Here is where the inspector whose sails were to be trimmed found the greatest number of violations. In some cases plants had been entirely rebuilt and larger engines or turbines installed, and still they were in charge of special license men, whose licenses were granted for the old plant.

The men who did this were violating the law just as much as though they held no license whatever. The representative from this part of the state who introduced the special license bill hoped to enable those plants to continue in charge of a special man. The power-plant owners themselves argued that removing these men threw out of employment men who had worked for them for years, and imposed a great hardship on men who had no other trade.

The bill failed to pass. Also, according to latest reports, the local inspector's sails are still flying and whenever he prosecutes he seems to have no trouble in winning his case.

Cheshire, Mass. A. W. Griswold.

[According to the ruling of the Board of Boiler Rules, a second-class license entitles the holder "to operate a first-class plant under the engineer in direct charge of the plant.—Editor.]

Value of Engine Inspection

It was necessary to renew the piston rod on a Corliss engine. A new rod was made, but when about to place the new rod in the bull ring it was discovered that there were three cracks in the body of the bull ring, which, of course, made it necessary to also make a new ring. Had it not been necessary to take the piston rod out of the bull ring the bad condition of the latter would not have been noticed until, perhaps, a serious accident happened.

This piston was examined about every six months, but the cracks in the bull ring were not noticed and I believe they would not have been found but for the fact that the piston rod and bull ring had to be heated to get the old rod out, which, of course, opened up the cracks so they could be seen.

H. A. Jahnke.

Milwaukee, Wis.

Piping Mine-Pump Air Exhaust

With reference to Mr. Houston's letter in the Apr. 22 issue, it is not stated clearly how he forces the exhaust from the air-driven pump into the discharge from the water end. He states that the pump operates against a head of 400 ft., or a pressure of 173 lb. per sq.in. It is difficult to understand how the exhaust from a pump taking air at an initial pressure of 90 lb. per sq.in. can be made to pass through a check valve with 173 lb. water pressure on the other side of it. An explanation of the above would be interesting.

Incidentally, Mr. Houston could have prevented the freezing of the exhaust by admitting a small stream of water near the end of the exhaust line. This is a very simple and effective method and causes no loss of power due to back pressure.

George H. Bridges.

Holyoke, Mass.

A Flood Experience

In reference to your editorial "The Afflicted Middle West," in the Apr. 8 issue, I want to say that the men in charge of the municipal plant here were certainly "up against it." The plant is near the river and was soon surrounded by water when the river began to rise. But the men stayed on the job, working with boots on until forced to abandon the plant, from which they were taken in boats. The traction company's power plant, being on higher ground, escaped the flood, and, although there is keen competition between the two companies, the traction company offered to supply current to all downtown users through the city mains. The offer was made to the city officials, and gratefully accepted.

They worked day and night, with the assistance of the Ft. Wayne General Electric works, getting things baked out. Ft. Wayne was the first city in the flood zone to have light. The water-works pumping station was also flooded, and the supply cut off three days. Then two locomotives were placed as near the pumping station as possible and a steam line was run to the pumps, which were still under water, and they began to pump water for domestic purposes. It takes a real engineer to be an engineer at a time like this.

Ft. Wayne, Ind. J. W. Fries.

Large High-Vacuum Condenser Test

Referring to the article on page 278 of the Feb. 25 issue, on the test recorded by J. J. Brown, covering a 25,000-sq.ft. turbine-base surface condenser; 36-in. double-suction volute pump, driven by a Corliss engine; 14x36x24-in. dry-vacuum pump and two double-suction hotwell pumps; the writer has figured, according to the geometric mean, the B.t.u. heat transference of the five guarantees as specified on page 280, using the formula given on page 281, in accordance with which the guarantees, all based on circulating water at 70 deg., 34,000 gal. per min., are as followed:

28.3-in. vacuum, 210,000 lb. of steam per hour 427 B.t.u.
28.5-in. vacuum, 185,000 lb. of steam per hour 449 B.t.u.
28.6-in. vacuum, 155,000 lb. of steam per hour 396 B.t.u.
28.7-in. vacuum, 125,000 lb. of steam per hour 349 B.t.u.
28.9-in. vacuum, 70,000 lb. of steam per hour 266 B.t.u.

These guarantees can be met by a new apparatus in good condition and clean tubes.

The circulating-pump conditions as given are apparently correct, figuring up to a head of 14 ft. when 36,000 gal. per min. are delivered through the condenser, which checks.

In Table 2 is a test in July, 1910, where the heat transference is recorded as varying from 403 to 550 B.t.u.; the latter figure is given in only one instance and under the following conditions: Vacuum, 28.286 in.; the temperature corresponding to vacuum, 96.15 deg.; hotwell temperature, 90.3 deg.; circulating water, 73.4 deg.; inlet, 86.9 deg.; outlet, steam condensed, 210,000 lb. per hour.

No mention is made of where the vacuum reading was taken, nor whether it was taken simply through a hole drilled in the base, or through a perforated pipe, so that the velocity of the steam would not affect the reading. It should have been taken in the latter way, and at several points; also, the steam temperature should be an actual reading and not recorded as the temperature of steam corresponding to the vacuum, as in this test, without any statement as to where the vacuum reading was taken. It will be noted in the article that this condenser contains rain-plates.

It is fair to assume that there was a considerable loss in pressure between the space beneath the turbine buckets and the dry-air suction openings, and if the reading given was taken at the air-pump suction, and there should be 1 in. loss through the condenser, the figures will change as follows: Vacuum, 27.286 in.; temperature corresponding to vacuum, 111.6 deg.; steam per hour, 210,000 lb.; hotwell temperature, 90.3 deg.; circulating water, the same as given by Mr. Brown. These conditions, instead of giving 550 B.t.u. transference, give only 266 B.t.u., a very poor instead of a very good efficiency. It is necessary to give the readings both at the air-pump suction and beneath the turbine buckets and the test record is incomplete and misleading without such particulars.

On page 280, Table 1, is a test of the dry-vacuum pump, the mechanical efficiency being figured from the mean effective pressures in the steam and air cylinders and their relative volumes. This efficiency averages about 85 per cent., but no statement is made as to the vacuum maintained, which is very important, since a dry-vacuum pump obtains its least efficiency at perfect vacuum, and its highest mechanical efficiency at the greatest load, which is at about 19 in. vacuum. I judge from the average mean effective pressure recorded from the air cylinder, about 15.4 lb. per sq.in., that the machine was operating with between 27 and 27½ in. vacuum when these readings were taken, under which conditions it would show a higher efficiency than when operating under the guaranteed conditions of between 28.3 and 28.9 in.

It would be interesting to know whether Mr. Brown would guarantee these efficiencies when operating a high vacuum covered by the five conditions upon the apparatus. Under test conditions, somewhat better results are likely to be obtained than under running conditions, for which the guarantees should be suitable.

CARL GEORGE DE LAVAL.

Orange, N. J.

Firemen—and Firemen

The foreword, "Firemen—and Firemen," in the Apr. 29 issue, gives the impression that the Mallet locomotive fireman's work is unusually hard, the hours long and the compensation small.

The firemen represented at the hearing mentioned in the note at the top of the page are mainly employed by Eastern railroads, and the locomotive firemen in New England have much the best of the comparison. To begin with, there are no Mallet locomotives used in this section. It is a mighty poor fireman who cannot earn $75 per month on any run where he can put in at least 60 hr. per week. On some express runs his actual time is 40 hr. per week, for which he receives over $100 in the month.

Consider the duties of a locomotive fireman, such as cleaning, etc. Once he had to polish the brass and clean the locomotive. Today he cleans nothing below the running board, and what he does clean is usually very poorly done. Frequently the runs are short, with many stops, so that he has just as much of a snap as many of the stationary firemen.

As to the fierce heat, almost any stationary boiler will scorch one's clothes if it is run hard enough. Where a stationary man has considerable space to cover in firing, and the coal is not always handy, he frequently has to go outdoors and wheel it in as it is needed. On a locomotive the coal is always at hand, there is never more than two doors to fire into, and the fireman does not lift or throw the coal in large shovelfuls.

I do not believe the foreword represents the facts. New England firemen after 60 hr. work on the lightest runs get more than the above mentioned wages. According to one prominent railroad, the men are paid by the mile, and as the Mallets will cover many miles, the firemen should make good wages.

After reading such a statement many might believe that locomotive engineers and firemen are down-trodden and underpaid, but, as a whole, they are far stronger and better organized than any of the stationary engineers or firemen and are much better paid.

Neither must they possess the general knowledge required of the stationary engineer. While it does not pay to have a grouch or sit and think how hard our lot is, I do think the locomotive fireman's job is no harder than that of the stationary fireman.

G. H. KIMBALL.

East Dedham, Mass.

INQUIRIES OF GENERAL INTEREST

Operating Turbine without Dry Air Pump—In a modern turbine station, how could the turbine be kept running if the dry air pump should give out?

R. A. C.

Failure of the dry air pump would mean a reduction of the vacuum, which could only be compensated by raising either the pressure or the amount of steam admitted to the turbine either in the initial or secondary stages.

Single-Eccentric Corliss Engine Cutoff—How late in the stroke can a single-eccentric Corliss engine cut off, and why not later?

J. K.

Usually such an engine does not cut off later than one-half stroke, and cannot be made to do so without interfering with the proper action of the exhaust valves.

Sizes of Water-Tube Boilers—What limits the size of water-tube boilers equipped with mechanical stokers? Why not make them 3000 or 5000 hp. instead of 300 to 600 hp.?

R. A. C.

There is no limit to the size except as a matter of convenience and for commercial reasons. Boilers are not made larger because of the necessity of cutting out too much capacity when one boiler is down for cleaning or repairs. Further, larger units could not as closely aggregate any given capacity required and little elasticity for the supplying of variable demands for steam would be possible.

Steam Regenerators—How much water should a steam regenerator contain in relation to the size of the turbine it serves?

W. T. F.

Generally about ten times the quantity of water used per hour by the turbine, i.e., the weight of water in the regenerator should be about ten times the weight of steam consumed per hour by the turbine.

Diamond Patch on Boiler—A diamond patch is to be put on a boiler having a seam efficiency of 75 per cent., and the patch efficiency is to be the same. How should it be applied?

G. H. A.

The patch corners should be rounded. If the sides make an angle of 45 deg. with the boiler axis, single riveting will be as efficient as double-riveting of a horizontal seam. The latter being 75 per cent. with the same size and pitch of rivets for the patch, its efficiency will be the same.

steam turbine determined?

W. T. F.

Steam-Turbine Horsepower—How is the horsepower of a

The theoretical horsepower of a steam turbine is determined from computation of the energy developed by the steam which is used, in falling from the initial to the discharge pressure of the steam. The actual horsepower is determined by measuring the electrical load driven by the turbine, or by an absorption dynamometer.

Necessity of Dry Air Pump—Are dry air pumps necessary with all condensing turbine installations? If not, why not?

R. A. C.

No, they are not with certain apparatus. Tests have been made in which as high as 29 in. of vacuum was obtained and no dry air pump used. With ordinary condensing equipment the dry air pump is preferable but not necessary. Its advantage is that it reduces the size of wet vacuum pump required by relieving the latter of handling vapor and air and thereby increases the degree of vacuum that can be maintained.

Triplex vs. Duplex Power Pumps—What are the advantages of triplex as compared with duplex power-driven pumps?

T. H. M.

The advantages are that the discharge of the triplex pump is steadier and there is less clattering of the check valve on the boiler or tank supplied by the pump. The disadvantages are that there is rather more piston or plunger friction in proportion to the amount of water handled and for pumps of equal capacity, the triplex having smaller pistons or plungers and also smaller water passages, there is greater frictional resistance offered to the water and the percentage of slip is higher.

Water-Turbine Supply—With a fall of water available of 67 in., how many cubic feet of water per minute would be necessary to operate a 20-hp. turbine?

J. A. B.

If by available head is meant the head over and above all losses sustained in bringing the water to the wheel, or by back water in the tailrace the available head can be taken as the actual head. Probably there is some loss at the point where the water is discharged from the wheel by "piling up." To allow for this it would be about right to deduct 7 in., leaving 60 in., or 5 ft., as the actual working head. A good turbine will have an efficiency of about 75 per cent., so that the "horsepower in the water" would have to be

$$\frac{20}{0.75} = 26.66, \text{ or}$$

$$26.66 \times 33{,}000 = 879{,}780 \text{ ft.-lb. per min.}$$

Falling 5 ft., the weight of water required would be

$$\frac{879.780}{5} = 17{,}595.6 \text{ lb., or}$$

$$\frac{17{,}595.6}{62.4} = 281.9, \text{ or, roundly, } 282 \text{ cu.ft. per min.}$$

Pop Valve Sizes—Two boilers are of the same dimensions and same tensile strength, but one carries 150 lb. pressure and the other 100 lb. Which should have the larger pop valve?

J. P.

Regardless of whether or not the boilers are of the same tensile strength the one at lower pressure should have the larger valve to relieve it of the same weight of steam in a given time. This is shown by the familiar formula for the area of safety valve to use under given conditions, i.e.,

$$A = \frac{W70}{P} \times 11,$$

where

A = Area of valve in square inches per square foot of grate;

W = Weight of water evaporated per square foot of grate.

P = Pressure (abs.) at which valve is set.

Other things being equal the valve area must be increased when the pressure is decreased. The boiler being safe up to 150 lb., the same size valve would be large enough, so far as the boiler is concerned, but for the piping and equipment beyond the boiler there may be reason to keep the pressure from exceeding 100 lb.

Contents of Boiler—What will be the water contents in cubic feet of a horizontal tubular boiler 66 in. in diameter, 16 ft. long, having 57 tubes 4½ in. in outside diameter, and the water level 15 in. from the top of the shell?

R. S.

The volume of water in the boiler will be the net cross-sectional area multiplied by the length (16 ft.). The cross-sectional area will be the cross-sectional area of the shell minus the cross-sectional areas of all the tubes minus the cross-sectional area of the steam space (a segment of a circle).

The cross-sectional area of the shell is

$$\frac{66 \times 66 \times 0.7854}{144} = 23.758 \text{ sq.ft.}$$

of the 57 tubes

$$\frac{4.5 \times 4.5 \times 0.7854}{144} \times 57 = 6.294 \text{ sq.ft.}$$

of the steam space

$$\frac{0.13395 \times 66 \times 66}{144} = 4.052 \text{ sq.ft.}$$

(for the method see Engineers' Study Course, 'Power," Apr. 1, 1913, page 468. 0.13395 is the area of the proportional segment of a circle of unit diameter and is found from a table of circular segments, after finding the height of the proportional segment by dividing the boiler diameter by the height of the steam space $\frac{15}{60} = 0.227$.)

Then the net cross-sectional area is

$$23.758 - 6.294 - 4.052 = 13.412 \text{ sq.ft.}$$

and the volume

$$13.412 \times 16 = 214.59 \text{ cu.ft.}$$

ENGINEERS' STUDY COURSE

Analysis of Coal—II.

Apparatus Required for Proximate Analysis

The following pieces of apparatus or their equivalent are required for making a proximate analysis:

1 chemist's balance (sensitive to 1 milligram)	$12.00
1 set of weights (50 grams to 1 milligram)	2.25
1 porcelain crucible with cover (15 c.c. capacity)	0.15
1 iron ring stand or iron tripod	0.25
1 Bunsen burner or gasoline blow torch, 25c. or	2.75
1 desiccator (sulphuric acid) (4 in. in diameter)	1.25
1 lb. sulphuric acid (chemically pure)	0.30
1 drying oven	1.10
1 100-mesh sieve (small size)	1.40
1 mortar and pestle (porcelain)	0.35
2 porcelain insulated wire triangles (2-in.)	0.15
1 pair crucible tongs	0.35
1 coffee mill (cast iron)	1.15
	$23.45

Thus, you see, for a total cost of less than the price of a good steam-engine indicator any man can own the means of examining the coal used in his plant. And, although the indicator is a splendid instrument for effecting economy, it is even more important to examine into the character of the coal you purchase. If the ash or moisture content in a certain lot of coal is larger than normal, you should know it and take steps to avoid being "stuck" in a similar way again. If the character of the combustible part of the coal undergoes a marked change you should know it in order that the firing methods may, if necessary, be changed to suit.

It certainly is to the best interests (in every sense of the word) of every engineer operating a coal-burning plant, to analyze, if not a sample from every shipment of coal received, at least frequently enough to know with fair certainty whether the character of the coal changes, and to keep a record of all analyses together with the price of the coal from year to year for the purpose of future reference.

Now, the cost shown by my list may be reduced somewhat by substituting home-made apparatus and this point will be taken up as we discuss each individual piece.

The Balance

The most important piece of apparatus is the balance and the price given in the list is that of about the cheapest that can be used. More sensitive balances, capable of giving close results, would cost $25, $50, $75 or $100. But for the average power-plant requirements the $12 balance is satisfactory when used carefully. An actual picture of such a balance is seen in the assembly view, Fig. 2, and a sketch is given in Fig. 3.

The box rests on three legs, a stationary one at the rear and the two adjustable ones A at the front of the sides, by means of which the balance is leveled. The leveling in the present case must be done by placing a small spirit level on the top of the box, first extending left and right, then front and back, and adjusting the thumbscrews to suit. Some balances are fitted with a small plumb-bob for leveling, in which case the spirit level is unnecessary.

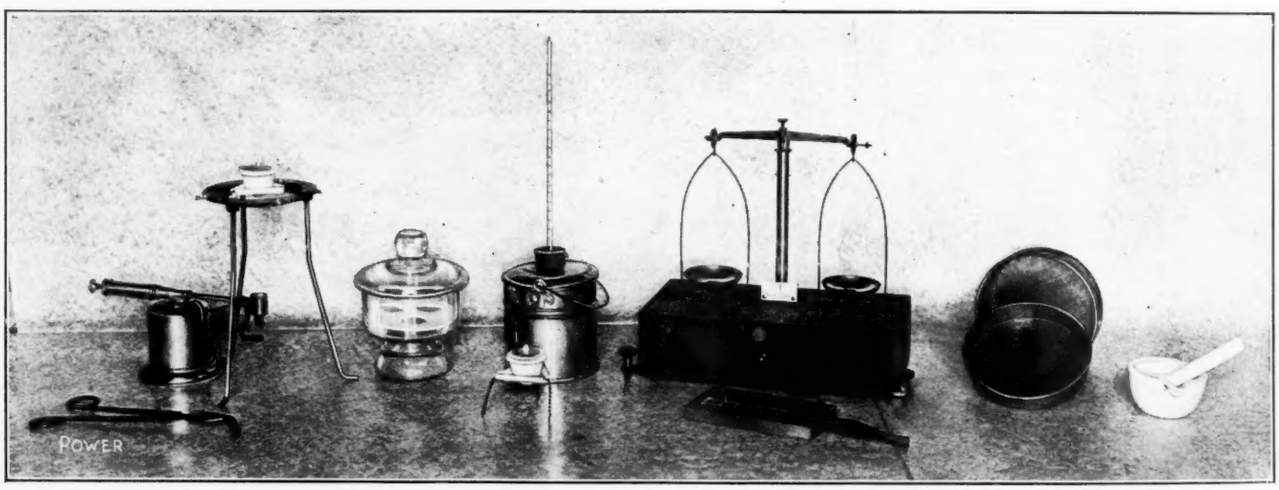


Fig. 2. Apparatus Required for Proximate Analysis

The balance beam, fitted with a small knife-edge shaft of hard steel at its middle, rests in the saddle B, at the top of the upright, which has V-shaped hard-steel bearings. A hard-steel knife-edge shaft at each end of the beam carries a stirrup with hard-steel V-shaped bearings from which the scales are hung. The scale pans C are removable. The saddle B is raised and lowered by means of the thumb-screw C; in the lowered position the scales rest on the box, as shown; in the raised, they clear the box by about 3/8 in. and the beam is thus free to swing and indicate whether the contents of the pans are equal in weight or not. The object of this arrangement is to make it more easy to load and unload the pans. The balance is so sensitive that if you attempted to lift one pan off or take out or put in a weight much greater than one gram, the other pan, unless first supported or steadied, would bang down on the box and perhaps upset whatever it contained or even dislocate its stirrup on the beam above. Thus, before greatly disturbing the equilibrium it

is convenient to lower the pans so that they rest on the box. Of course, when weighing, after an approximate balance has been established, the addition to or removal from the weight pan of a weight of 200 milligrams or less does not make the balance swing violently and the pans need not be lowered.

Before weighing, the balance should be tested by putting the empty pans in the scales, raising the beam and noticing whether the pointer *D* either remains on the center line of the scale *E* or swings an equal number of divisions to each side of the center line. If slight adjustment is necessary this can be made by turning the adjusting screw *F* one way or the other until the balance is correct. Best results are accomplished when the balance is placed where it is free from even the slightest air currents and uneven variations in temperature. The more expensive balances are housed in glass cases which have fronts that slide up and down, the cases being closed when the final balancing is being tried. The ingenious man who wishes to get the best results with his $12 balance may build a glass case for it, constructing the case, of course, so that the thumb-screw *C*, for raising and lowering the scales, projects through the front and can be manipulated when the front is closed.

The weights are furnished in a special box which has compartments for each size and they should always be kept in the box. As soon as a weight is removed from the balance it should be placed directly in its compartment and not laid upon the table or anything else when it is in danger of becoming lost, dirty or damaged. A pair of forceps for handling the weights is furnished with every set and should always be used in preference to the bare fingers as moisture from the latter is liable to cause tarnishing or the accumulation of dirt, or other foreign matter.

The weights are based on the French or metric standards; the units used being grams and milligrams. The reason for using the French units instead of the English pounds, ounces, etc., is that as the French units are based on the decimal system they make calculation more simple. A gram equals about 0.035 of an ounce. One milligram equals $^1/_{1000}$ of a gram, and, hence to reduce grams to milligrams or *vice versa* it is simply a matter of adding the right number of ciphers or locating the decimal point. To illustrate, 526 milligrams equal 0.526 gram; 62 grams equal 62,000 milligrams; 13.27 grams equal 13,270 milligrams, etc.

One set of weights consists of one 50-gram, two 20-gram, one 10-gram, one 5-gram, two 2-gram, one 1-gram, one 500-milligram, two 200-milligram, one 100-milligram, one 50-milligram, two 20-milligram, one 10-milligram, one 5-milligram, two 2-milligram and one 1-milligram weights, so that their range is from 1 milligram (0.001 of a gram) up to 111.11 grams advancing by milligrams.

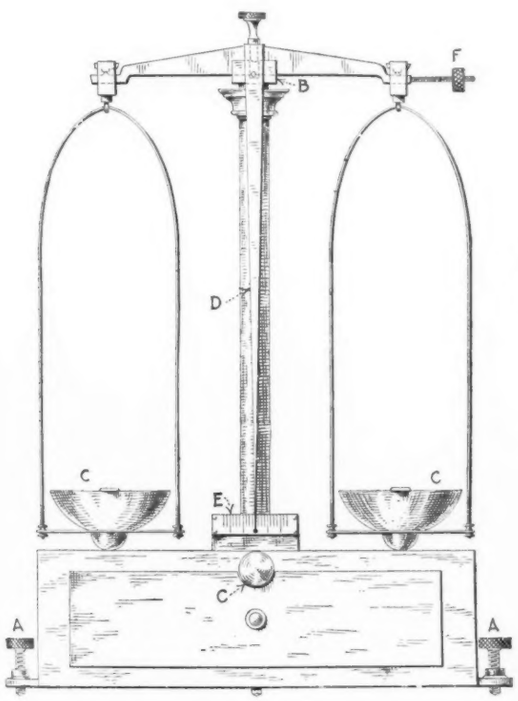


Fig. 3. Construction of Balance

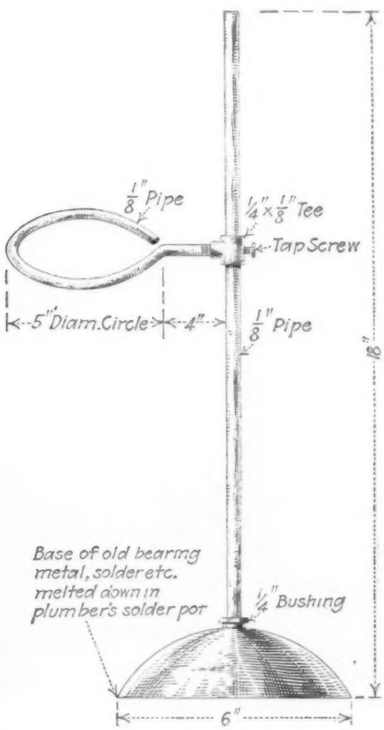


Fig. 4. Home-Made Ringstand

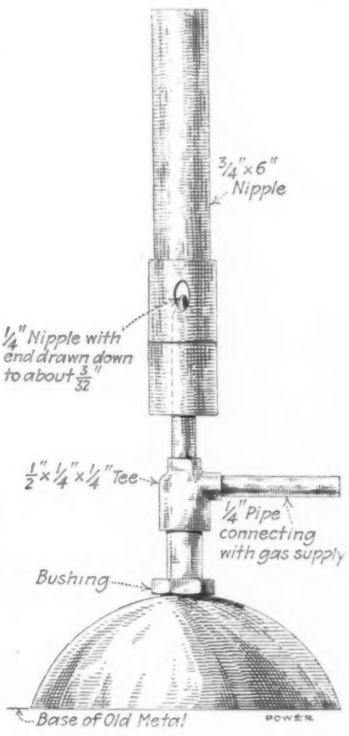

3/4" x 6" Nipple
1/4" Nipple with end drawn down to about 3/32"
1/2" x 1/4" x 1/4" Tee
1/4" Pipe connecting with gas supply
Bushing
Base of Old Metal
POWER

Fig. 5. Home-Made Bunsen Burner

Crucible

The crucible is the little vessel in which the sample of coal is heated. One made of porcelain will answer all our purposes. In ordering, specify the 15-c.c. size with lid. Its cost is so small that while a fair substitute could be devised it is not worth while doing so as the extra care required in handling would more than offset the saving effected.

The ring stand, shown in Fig. 4, can easily be made from 1/8-in. iron pipe and fittings, and, being adjustable, it is more convenient to use than the tripod shown in Fig. 2.

If a good supply of gas is available (as in almost any city) a bunsen burner is the most convenient form of

heater to use. If not, a gasoline blow-torch, such as shown in Fig. 2, will be needed; or an ordinary plumber's or electrician's torch will do nicely. The latter, however, usually gives a horizontal flame and will have to be tilted a little in order to make the flame strike the oven or crucible to best effect.

A home-made bunsen burner as per Fig. 5 will give just as satisfactory results as a purchased burner. To regulate the air supply a loose sleeve is placed above the union on the ¾-in. nipple and is provided with four holes to match the holes in the nipple.

Desiccator

When the moisture has all been driven off from the sample of coal by the first heating and the sample is dry and still hot it would rapidly absorb moisture from the air if left exposed to it in that condition. And the same thing would happen after each subsequent heating if the sample were left exposed to the ordinary air.

Hence, the sample is transferred direct from the oven or from the tripod to the desiccator or drier to cool off

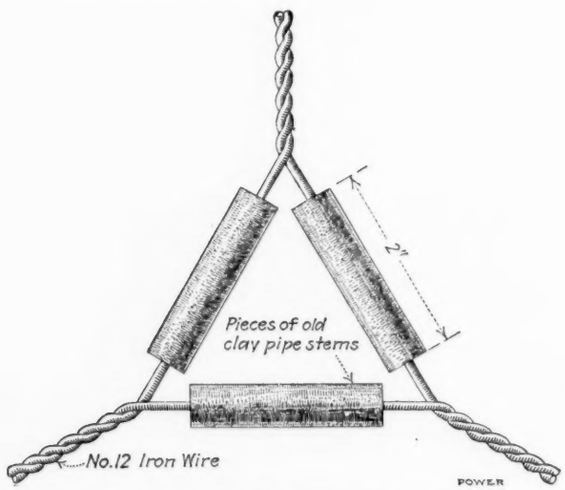


Fig. 6. Home-Made Triangles

before being weighed. The commonest form of desiccator is that shown in Fig. 2. It consists simply of a glass jar and lid; the joint between jar and lid being ground to an air-tight fit. The lower part or well of the desiccator is about quarter or half filled with pure sulphuric acid. The upper part contains a glass or porcelain tray upon which to set the crucible containing the sample of coal.

The principle of the desiccator is this: Sulphuric acid has a strong affinity for water or moisture. Hence, with an air-tight lid, what little moisture there is in the air entrapped in the desiccator is soon absorbed by the acid and the hot sample of coal does not get a chance to absorb any moisture and thus cause an error in the analysis.

One pound of chemically pure sulphuric acid (enough for use in the desiccator for a long time) can be purchased for 30c.; this includes the glass-stoppered bottle to contain it. How long the acid in the desiccator will remain effective depends on the manner in which it is used. If means are available for accurately weighing the acid or the desiccator before and after the acid has been put in, the acid may be renewed when the gain in weight is equal to 25 per cent. of the original weight of the acid. To illustrate, suppose ¼ lb. (or about 113 grams) of the dry acid were put into the desiccator and after six months or a year, the weight was found to be 5 oz. (a gain of 25 per cent.) it would then be advisable to refill the desiccator with fresh acid. If it is not convenient to check up the condition of the acid by weighing, it is safest to renew it about once a year.

Great caution must be used in handling sulphuric acid as it will attack or "eat away" the clothing, also iron, copper and many other metals. And, if it comes in contact with human flesh it causes a bad burn. Keep the bottle where it is not in danger of being broken and be sure that none of the acid is allowed to spill out of the desiccator. Also, never allow any water to come in contact with the acid as much heat is generated thereby and the acid might splatter on the face or hands. Always keep the lid on the desiccator to prevent the acid from absorbing moisture from the air and thus becoming weakened too soon.

Drying Oven

The drying oven is used for the first heating of the sample to determine the moisture content.

If you were to purchase a standard oven it would cost at least $5. The oven shown in Fig. 2 can be manufactured for $1.10 or even less. Secure a 1-qt. tin pail (about 4 in. in diameter by about 4¼ in. high) cost 10c. Punch a hole, about 1¼ in. in diameter, in the center of the lid. Next, secure a good sound cork to fit the hole and bore a hole in the cork so that the thermometer will fit in it snugly, as shown.

See that the lid of the pail fits loosely so that it can be removed without the necessity of holding the pail, as the latter will be hot and awkward to handle most of the time and the sample might be spilled if force is used. If necessary, cut off or bend in the flange on the lid. Punch one or two small holes (⅛ in. in diameter) in the side of the pail close to the bottom also one or two in the lid to provide for a small circulation of air.

Purchase a chemical thermometer having a range from zero to 200 deg. C., cost $1. Insert this in the cork, as shown in Fig. 2, so that the bulb projects into the pail about 1¾ in.

Bend down the ends of a porcelain-insulated wire triangle so as to form a little stand for the crucible, as shown in Fig. 2. Put this stand in the pail and place the pail on the ringstand or tripod over the burner and our home-made oven is ready for "business."

The next item on our list, the 100-mesh sieve, is desirable but not absolutely essential. It is used for sifting the sample before the analysis. If economy in first cost is imperative, the sample may be prepared without sifting, but extreme care should be used to crush the sample uniformly and as fine as possible.

The mortar and pestle, for crushing the sample, may also be dispensed with if desired; but the price is so small and they are so convenient that this is not recommended. If the sample is crushed with a hammer in an iron pot, on a sheet of iron, slab of stone or other hard surface, care must be taken that particles of incombustible foreign matter do not get mixed with the coal, thus causing an error in the analysis.

The next item on the list, the porcelain-insulated wire triangles, are used, one for supporting the crucible on the tripod or ringstand over the flame, the other, bent as just described, for supporting the crucible in the dry-

ing oven. Satisfactory home-made triangles may be made as shown in Fig. 6.

The crucible tongs, shown in Fig. 2, are used for handling the crucible and lid throughout the analysis. A pair of home-made tongs could be devised, but it is doubtful if the effort is worth while as they probably would not be as "handy" or as smooth working as a purchased pair.

The last item on the list, the coffee mill, is employed to coarsely grind the sample before it receives the final mixing and crushing. If an old coffee mill is available, so much the better, as it will answer just as well as a new one and the cost of the new one will be saved. It should be strong enough, however, to stand the service. One made of cast iron would be suitable.

Pumping under Difficulties

The photograph shows the pumping station at South Glens Falls, N. Y., just prior to the flooding of the pump and boiler rooms.

This little station is on the bank of the Hudson River and delivers water to a standpipe 18 ft. in diameter, 125 ft. high on a hill to the left and not shown in the photograph. This tank holds the only water supply for the town.

Thirty-six hours after the photograph was taken the water had risen level with the top of the "No admittance" sign between the door and window, and thus flooded the

PUMPING STATION THIRTY-SIX HOURS BEFORE WATER REACHED HIGHEST MARK

boiler room, putting out the fires. When the water began to rise rapidly the pumps were started so as to fill the standpipe and increase the supply available from the tank. The boilers are hand fired and use natural draft. The plant was kept in operation until the water rose so high in the ashpits that the draft became inadequate to burn the coal. The plant was out of commission for 36 hours and the town was without water for 17 hours.

The only real damage to the plant was the breaking of the stack at the uptake. This was caused by a log jam lodging against one of the guy wires, and pulling the stack over enough to break the uptake. Sheet asbestos and sheet tin wired around the break serve to give draft enough to operate the boilers. As soon as the water receded below the grates the fires were started.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Know anything about wabbling that you're not ashamed to tell? In the May 13 issue this question is propounded: "Shall we let the foot-pound wabble or vice versa?" As Prof. Kent says there's no need for its wabbling, shall we let it vice versa? Or just wriggle or turkey-trot? What's the difference between a wabble and a vice versa?

No, Eliphalet, we're under no obligation to climb genealogical trees and shake down any reader's ancestors. We will oblige by stating that there was an Eliphalet O'Reilly in the War of the Revolution. Here also are recorded a few more euphonious names that today would savor of lost motion: euphonious names that today would savor of last motion: Ebenezer Murphy, Ichabod O'Flanagan, Abel Kelley and Esau Sullivan. 'Twas Kelley that put over that stirring war-cry, Erin go unum e pluribus bragh, which freely translated means that the Irish stand united in the belief that God loves them!

"Seventy-five men and women were startled when the dynamo of the machine exploded," says the New York "Times." Startled? This announcement would startle a New York street-car horse, one of the most prepossessed beasts in captivity.

When you make a Kansas engineer believe that you say something when opening your mouth and you hit straight from the shoulder, and your slogan is "Fair play for us all"—you can be sure you're a man and a brother. Frank Thomas, supervisor of the Santa Fé Ry. apprentices, did just this thing at the Topeka convention, and the boys made him an honorary member of the N. A. S. E. "Any Tom, Dick or Harry can't be a good engineer," said Frank. "Yours is a profession requiring talent and brains."

Bully and some!

Aweisenheimer is trying to scare us by saying there's 35,000,000 bacteria in a cubic inch of ice cream. That we should become disturbed! We're all chuck full of these things. We've carried 'em around so long that the wildest "bac." eats out of our hand. Some of you single chaps, though, might use the things as an argument when your best girl has you headed for the village ice-cream parlor.

"President Wilson would do well to train a few stationary engineers for his diplomatic posts abroad," writes T. F. White, over to Texas way. T. F. thinks that the s. eb's experience in managing subordinates and keeping persons grata with his bosses should ultimately fit him to cope with all questions of wars, stratagems and the unspeakable Turk.

STOP, LOOK, LISTEN!

By Billy Spills

Our well-intentioned correspondents are hereby warned that this spillway will soon slop over if it continues to be crowded by items on hints to mothers, physical ailments or patent devices. Your Uncle Spills is neither a diagnostician, a patent-attorney, an encyclopedia, nor—

Here, read two samples of this stuff for yourself:

Dear Billy: My husband thinks our baby will be a humorist when he grows up, as every little while he (the baby) has a pimple on his nose. Is a pimple a sign of humor?

MRS. BOYLE.

Friend Bill: I'm quitting engineering. Got a good thing if I can get it patented. It's a collar-button with a whistle on it. Am sending a blueprint so's you can get a line on it. What do you think of it? Have been experimenting with a hollow nut, but there's nothing in it.

JOHN BUGG.

Mrs. Boyle's husband's baby's pimple is sure humorous. What he'll be when he grows up is beyond my ken; he might get rash before he grows up.

As for John Bugg's whistling collar-button, and his blueprint with a line on it, and his hollow nut—

Say, John, you stick to engineering or your folks will have to pay your board in a psychopathic ward and you'll be hearing that collar-button whistling through your hollow nut.

Gasoline Explosion in Power Plant

By L. Claire Hulbert

On May 7 the building of the Lapeer Gas-Electic Co., of Lapeer, Mich., was destroyed by an explosion and fire. As the firm name indicates the company supplied electric and gas service. The gas was made from gasoline which was stored in tanks under pressure.

The day engineer, who was alone in the building at the time, was responsible for the accident. He attempted to empty a drum of high-gravity gasoline without reducing the pressure to atmospheric before removing the stopper. The engineer's clothes were saturated with the gasoline and the room was immediately filled with vapor.

Fig. 1. Photograph Taken about 15 Min. after Explosion, Showing Damage to Wall

Fig. 2. Just after Explosion of a Drum of Gasoline

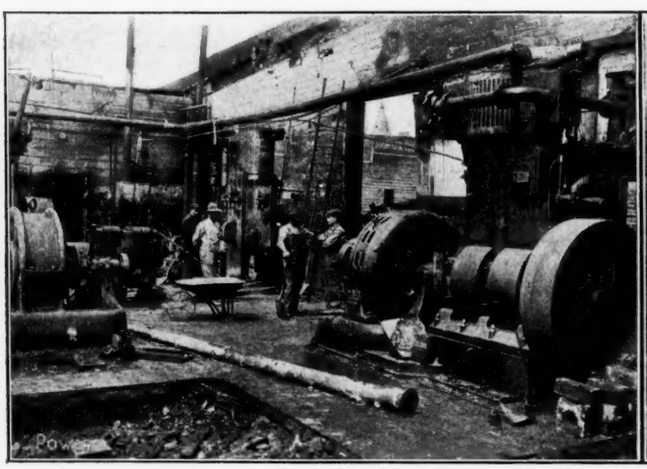


Fig. 3. Engine Room on the Morning after the Fire

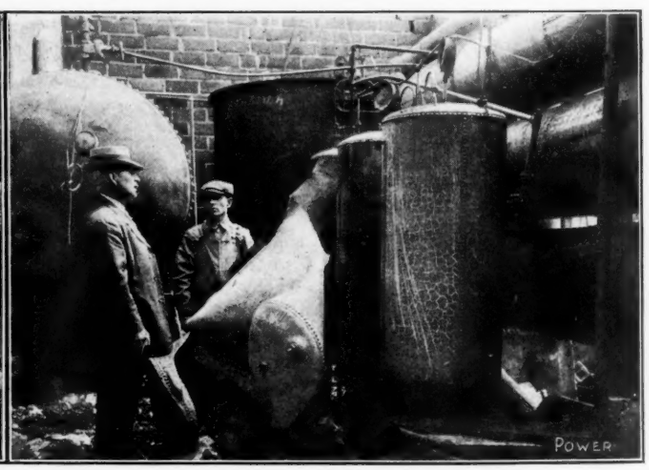


Fig. 4. Destruction in Gas Room

Some of this must have penetrated through the fire wall to the boiler room adjoining, and the explosion followed. The entire wall of the gas room and the large plate-glass window of the office were blown out and flames filled the building from end to end. The engineer's clothes caught fire before he could escape, causing burns which resulted in his death a few hours later.

Several drums of gasoline exploded as the fire reached them. The bottom of one tank gave way and it ascended like a skyrocket about 200 ft. in the air. It landed on the sidewalk, where it is shown in the middle foreground of Figs. 1 and 2. Fig. 3 shows the engine room as it appeared after the fire, and Fig. 4 the gas room.

The company used every effort toward getting the plant in shape and were able to furnish light to their customers on Saturday, May 10, the third day after the accident.

Power Plant with a 5412-Foot Head

A water-power scheme of 5412-ft. head has not, heretofore, been heard of, but has been considered impracticable in technical circles. Mr. Boucher, of Lausanne, civil engineer, after whose plans many water-power schemes, with a comparatively high head have been already carried out, made it his aim, as a member of the board of Administration of the Societe d'Electro-Chimie, of Paris, to convert the water power of the Lake of Fully, near Martigny, in Canton Wallis, Switzerland, with such a high head as hitherto has never been used, namely, 5412 ft., into electric energy. The execution of this project has in the meantime been resolved upon, the orders for the necessary materials placed and the work commenced.

The most interesting question in connection with this scheme arose when deciding in what manner the pipe line should be constructed in order to withstand a pressure of 2343 lb. per sq.in. at the lower end. However, a most satisfactory as well as perfectly simple solution was found.

The pipe line in a length of about 2¾ miles consists of pipes with inside diameters of 19$\frac{11}{16}$ in., and 23⅝ in.

and thicknesses of from $^{15}/_{64}$ in. to $1\frac{5}{32}$ in. The pipes of the upper section will be of the well-known water-gas, lap-welded type, whereas those of the lower part will be seamless.

The 15,000-hp. turbines will be built by Piccard, Pictet & Co., Geneva, the construction of the pipe line is in the hands of Thyssen & Co. at their Muelheim-Ruhr steel, plate and tube works.

Boiler Explosion Fatal

At noon, Tuesday, Apr. 22, the horizontal tubular boiler at the Thompson brick yard and sawmill, Mt. Pleasant, Mich., exploded, killing three men, and seriously injuring several other persons. William Thompson, owner of the mill and acting engineer, was instantly killed. The damaged mill is shown in Fig. 1. The boiler was about 30 years old and was formerly operated in a mill, and went through a fire when the mill was burned. The dimensions of the boiler were 50 in. by 14 ft., and it contained seventy 3-in. tubes, several of which had been leaking and were plugged. More were welded with questionable success. The shell was of 3/8-in. iron when new, but it had corroded so badly in places that it was exceedingly thin. The force of the explosion was toward the rear, and the tubes, bent and twisted, were scattered over a space 200x100 ft. The dome, a part of the shell and the front head were thrown 300 ft., landing as shown in Fig. 2.

It is said that the boiler had long been in an unsafe condition and last season the owner installed a motor supplied with outside current to run the brick yard, but insisted on running the boiler for the sawmill because the sawdust and chips furnished cheap fuel.

It is reported that there had been trouble with the feed pump the day before the explosion. The safety valve started to blow just an instant before the explosion, which would indicate that overpressure was the cause. The boiler had received its share of patches, two of which are shown in Fig. 2. Fig. 3 shows the damage wrought by the explosion. The boiler was of the lap-joint type.

FIG. 1. ENGINE ROOM AFTER THE EXPLOSION

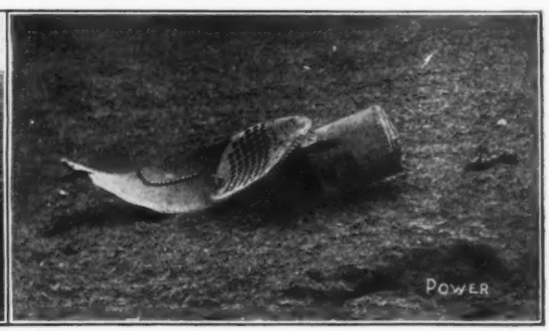


FIG. 2. FRONT HEAD AND DOME

FIG. 3. ANOTHER VIEW OF THE DAMAGED MILL

Clearance Measurement by Water

The following manner of determining the clearance space in engines is recommended by the American Society of Mechanical Engineers.

To measure the clearance by actual test, the engine is carefully set on the center, with the piston on the end where the measurement is to be taken. Assuming, for example, a Corliss engine, the best method is to remove the steam valve, so as to have access to the whole steam port, and then fill up the clearance space with water, which is poured into the open port through a funnel. The water is drawn from a receptacle containing a quantity previously measured. When the whole space, including the port, is completely filled, the quantity left in the receptacle is measured and the difference shows the

amount which has been poured in. The measurement can be easily made by weighing the water and the corresponding volume determined by calculation, making proper allowance for its temperature. The proportion required is the volume in cubic inches thus found, divided by the volume of the piston displacement, also in cubic inches, and the result expressed as a decimal. In the test care should be taken that no air is retained in the clearance space when it is filled with water.

The only difficulty in measuring the clearance in this way is that occurring when the exhaust valves and piston are not tight, and the water poured in, flows away and is lost. If the leakage is serious, no satisfactory measurement can be made, and it is better to depend upon the volume calculated from the drawing. If not too serious, however, an allowance can be made by observing the length of time consumed in pouring in the water; then, after a portion of the water has leaked out, fill up the space again, taking the time and measuring the quantity thus added, determining in this way the rate of leakage. Data will thus be obtained for the desired correction.

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Repairs to a Reinforced-Concrete Chimney

An interesting description of repairs to a reinforced-concrete chimney was given by C. E. Smith in the May 8 issue of *Engineering News*.

The chimney, built in 1903, is 160 ft. high. The lower 60 ft. is composed of a double shell and the upper 100 ft. of a single shell, the entire chimney being reinforced horizontally and vertically by mild-steel T-bars. The horizontal bars are 1x1x⅛-in. bent circular and the vertical bars are 1¼x1¼x¼ in.

The inner shell of the lower portion is 4 in. thick and has an internal diameter of 5 ft. It is reinforced by horizontal circular T-bars 18 in. apart and vertical T-bars 16 in. apart. The outer shell of the lower portion is separated from the inner shell by a 4-in. air space. The outer shell is 8 in. thick and has an external diameter of 7 ft. 8 in. At the top of the double-shell section of the chimney the inner and outer shells merge, vents being left in the inner shell for purposes of expansion.

Above this portion extends 100 ft. of chimney having a single shell with an external diameter of 6 ft., the thickness of shell being 6 in. for the lower 45 ft., 5 in. for the next 30 ft. and 4 in. for the top 25 ft. In the fall of 1912 it was noticed that during severe winds the chimney gave out a grinding sound and chunks of concrete fell from its outer surface, creating considerable alarm among the employees having duties near the base of the stack.

Close inspection from the iron ladder attached to one side of the chimney and by telescope of the remaining surface, indicated that the entire upper portion, 100 ft. high, was cracked vertically and horizontally into a large number of rectangular slabs, the cracks being located along the lines of the reinforcement and that the cracks would soon become so large as to permit corroding influences to reach the thin reinforcing members, which would have resulted in the early collapse of the chimney.

On account of the fact that the plant is almost continually busy, it was decided to make repairs without taking the chimney out of service.

The upper edge of the chimney had deteriorated so badly and the concrete there was so shattered and loosened that it was considered unsafe to suspend a swinging platform from the top, so a temporary timber staging resting on the ground was erected around the chimney, reaching to the top, and bracing was so arranged that platforms could be placed at intervals of about 6 ft. From these platforms a very careful examination of the entire chimney was made.

It was found that the cracks were much larger and more open, and the chimney in much worse condition than was indicated by the preliminary examination. In many places the reinforcement was entirely exposed and had already deteriorated considerably by corrosion. It was decided to cover the entire 100-ft. upper portion with a reinforced-concrete shell 3 in. thick, and repairs were started immediately.

Before placing the reinforced-concrete shell all loose concrete that could be readily dislodged by a hand hammer was removed, the cracks and exposed reinforcement were brushed clean and all openings and cracks filled with grout. Deformed rods ⅜ in. in diameter were placed vertically 6 in. apart entirely around the chimney, the lower ends of these rods being set and grouted in holes drilled in the outer shell of the lower portion of the chimney. Deformed bars ⅜ in. in diameter were also bent around the chimney to form a spiral from top to bottom with 6-in. pitch. The rods were placed as nearly as possible 1½ in. from the outer surface of the chimney.

Four steel forms were used. Each lift consisted of two half-cylinders of No. 10 steel plates 3 ft. high stiffened top and bottom and at the ends by small angle iron in which bolts were placed to hold the sections together. The inside diameter of the forms when set up was 6 ft. 6 in.

The concrete was mixed "dry," to permit early removal of the forms, and was thoroughly tamped in place. Most of the concrete was placed when the temperature was slightly below freezing, but no precautions were taken to prevent freezing. As the chimney was in use throughout the work, having an external temperature of about 80 deg. F., the new concrete set rapidly and permitted the removal of the forms after 24 hr., which permitted the placing of about 12 ft. in height each day. The job cost about $2500.

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Multiport Exhaust-Outlet Valve

A chart, showing the internal construction of the Cochrane multiport safety exhaust-outlet valve, has just been issued. The device can be used either as a back-pressure valve for exhaust-steam heating or drying systems, or as an atmospheric relief valve in connection with vacuum condensers. The distinguishing feature of this valve, which is made by the Harrison Safety Boiler Works, Seventeenth and Clearfield Sts., Philadelphia, Penn., is that instead of a large disk, there are a number of small disks, each held to its seat by an independent spring.

The tension upon the springs is adjusted by a movable pressure plate, the motion of which is limited to prevent overloading. The adjustment of the pressure plate can be accomplished by a handwheel on the outside of the casing, or may be controlled from a distance by rods, chains, electric motors, hydraulic pressure, etc.

Because of the lightness and small travel of the separate disks the valve operates quietly and a measure of safety is secured by having a number of disks instead of but one.

The New Allis-Chalmers Co.

On Apr. 16 the Allis-Chalmers Manufacturing Co. took over the properties and entire operation of the business of the Allis-Chalmers Co., which has been in the hands of a receiver. This change marks the end of the receivership and the commencement of the administration of the new company.

From Apr. 16 all business will be conducted by the Allis-Chalmers Manufacturing Co., which starts out under promising conditions. It will operate all departments as conducted by its predecessor and will carry out all contracts on hand and has no bonded indebtedness nor liabilities. In addition to all assets of the former company, the new one has over $4,000,000 additional cash for new working capital, raised through the recent reorganization.

The new company will continue to operate the large West Allis Works and Reliance Works at Milwaukee, the Chicago Works, and in addition will control the operations of the Bullock Electric Manufacturing Co., Cincinnati. Otto H. Falk, Milwaukee, who for the past year has been receiver, and under whose management the business has shown marked improvement, has been elected president of the new company. The general offices will be at Milwaukee.

All the properties are in good condition and the inventories and working capital on a sound basis. The engineering departments are well equipped and the lines of product turned out are of the highest quality. Under these conditions it is believed that with the present careful and intelligent management the operations will show substantial profits.

Nashville Wants a Boiler Works

The Nashville Industrial Bureau has gathered statistics showing that there are more than 300 boilers bought annually in Nashville for enterprises that use batteries of from one to six boilers. At present these must be purchased in other markets, and the fact that other towns and villages within 100 miles use many boilers and that materials for the manufacture of boilers may be shipped from the steel- and iron-producing fields promptly and cheaply, makes Nashville an ideal spot for a boiler factory of large proportions.

The state of Tennessee is noted for its friendship to home manufactories and Tennessee-made products, says the Bureau, and with this assurance of support, a big factory is sure to be a money-maker from the start is the unanimous opinion of long-sighted business men who have been interviewed on the subject.

The industrial bureau courts inquiry from anywhere, and assures anyone interested that its facts are authentic and that its tip that here is a splendid opportunity for a money-making investment are worthy of consideration. The bureau will gladly furnish further information to persons who care to investigate.

The field is not only a fine one already for such an industry, concludes the statement, but is becoming more so each year. New enterprises using steam are springing up at intervals, and will continue to come here, for Nashville is rapidly adding to her greatness as a manufacturing center.

School Notes

During the Easter holidays a party of about forty electrical engineering students of Sibley College, Cornell University, took a short three-day inspection trip, Thursday Friday and Saturday, Apr. 3, 4 and 5. The first day was spent in the General Electric Company's plant at Schenectady, the second in its plant at Pittsfield, and the third in New York City. At Schenectady, between seeing the sights in the morning and afternoon, the students were the guests of the company at luncheon, where the visit was made pleasant by making and renewing acquaintance with many Cornell alumni, many of whom are recent graduates. The itinerary of the trip did not permit staying over in Schenectady, so the men left early for Albany and thence for Pittsfield.

The next day they were the guests of the General Electric Company's officers in the Pittsfield plant. Here a regular program was planned by the company's men. The morning session was started with a meeting called to order by Mr. Toby, who introduced the various speakers. Mr. Insull, assistant general manager of works, whose son is an undergraduate in Sibley, and Mr. Toby gave short addresses of welcome, after which representatives from five of the departments gave short explanations of the work in them. These departments were then visited, after which a buffet lunch was served in the company's new club house. Following another meeting, during which the work in the other departments was explained, the rest of the plant was visited. These introductory talks added much to the understanding of the work being done. In the shops the spot welding, oxy-acetylene welding and cutting, and high-tension testing demonstrations were especially interesting.

The next day, Saturday, in New York the men visited the power plants of the Interboro Rapid Transit Co. on Fifty-Ninth St. the Edison Waterside stations and one of the railway substations. The party then broke up and the men proceeded to their homes or on individual sight-seeing trips.

NEW PUBLICATIONS

GAS POWER. By C. F. Hirshfeld and T. C. Ulbricht, respectively professor and instructor of power engineering, Sibley College, Cornell University. Published by John Wiley & Sons, New York, 1913. Cloth, 5x8 in.; 209 pages, illustrated. Price $1.25 net.

In this little book the authors have undertaken the difficult task of presenting the subject of gas power in non-technical language, their aim being to meet the needs of the manual training student and others who have not had the necesary technical training to comprehend the majority of works on internal combustion motors. Of course, it has been necessary to omit many of the theoretical considerations entering into the problems of design and the book is in no sense a complete treatise. Nevertheless, it should afford the reader a very good general idea of the subject.

Briefly, the items covered are fuels, the development of internal combustion engines, the four- and two-stroke cycles, methods of cooling, governing, ignition systems, carburetors, gas producers, types of gas, gasoline and oil engines, the rating of internal combustion engines and their performance.

Representative apparatus of each type is described and the illustrations are well chosen.

STEAM BOILERS. By Cecil H. Peabody and Edward F. Miller. Third edition revised and enlarged. New York. John Wiley & Sons. Pp. 543 6x9-in.; illustrated; cloth. Price, $4.

The authors, professors of naval architecture and marine engineering and of steam engineering, respectively, of the Massachusetts Institute of Technology, are well recognized authorities upon the subject of steam boilers, and their book, which made its first appearance in 1897, soon took a foremost place in the literature of the subject. In the third edition, which has just appeared, the subjects of mechanical stokers, economizers and steam piping have been treated at considerable length, and the use and calculation of induced draft fans quite fully explained. Much new material on chimney draft, the result of work extending over a period of years, has been added, as has also a chapter on Coal Handling and Coal Handling Machinery. The chapter on Combustion has been extended to cover oil burning and to include the most recent analyses of American coals, together with a detailed description of coal calorimetry, as applied to the determination of the heating value of coal purchased on a heat unit basis. The chapters on Staying, Riveted Joints and Boiler Testing have been extended; in fact, hardly a chapter in the book has not been amplified to some extent, and the number of illustrations has been nearly doubled.

Matheson Joint Pipe

The National Tube Co., Pittsburgh, Penn., has issued an attractive booklet under the above title. It deals with the manufacturing advantages and use of the Matheson joint pipe, which is suitable for use in mines, water-works, irrigation systems, hydro-electric plants, compressed air or gas transmission lines, or wherever a lead joint is suitable with pipe lines ranging from 2 to 30 in. in diameter. The booklet contains 40 pages and brings out a number of new features not published in the first edition.

Kentucky N. A. S. E. Convention

The first of the Middle West state conventions of the National Association of Stationary Engineers, was held in Hopkinsville, Ky., on May 7, 8 and 9, this being Kentucky's eleventh annual convention.

The exhibit at the Armory was opened at 8 p.m., Wednesday, and an address of welcome made by W. A. Wilgus. H. R. Anness, chairman of the executive committee of the Central States Exhibitors' Association, responded in the absence of President W. L. Osborne.

The preliminary session was opened at 10 a.m., Thursday, by State President J. L. Shrode, who, after the invocation by the Rev. A. R. Kasey, introduced Mayor Meacham to welcome the delegates and visitors. National Secretary Ryan made the response.

The afternoon session was devoted to committee reports and routine business.

In the evening Frederick L. Ray gave an illustrated lecture on "Gas Engines" at the Avalon, after which the exhibits of the supply houses were inspected.

At the election on Friday morning the following were chosen for office for the coming year: C. Carroll, Louisville, president; George J. Jake, Hopkinsville, vice-president; A. J. Pohl, Louisville, secretary; Edward Kochenrath, Louisville, treasurer; R. A. Quinn, Henderson, conductor; W. L. Franks, Owensboro, doorkeeper; J. L. Shrode, state deputy.

After the installation the delegates and guests went to Campbell's Cave, where a barbecue was held until 5 p.m. In the evening, a reunion took place at the Elks Club, where old acquaintances were revived and new ones formed.

The next annual convention will be held in Louisville.

SOCIETY NOTES

The first annual dinner and entertainment of the New England Association of Commercial Engineers was held on the evening of May 17, at the Revere House, Boston. Among the guests were the mayor of Boston, John F. Fitzgerald, and Walter G. Diman, mechanical engineer, Manchester N. H. President Albert C. Ashton was the toastmaster.

PERSONALS

E. G. Lender, who for several years was chief engineer for the Prudential Insurance Co., Newark, sailed for Germany recently.

S. M. Reid, formerly chief engineer for the Rothschild Realty Co., at 98 Fifth Ave., New York City, has resigned to accept the position of chief engineer of the Continental Paper Co., Bogota, N. J.

Thomas P. Marshall, after 20 years of service, has retired as superintendent of the operating department of the Toronto (Ont.) Electric Light Co., Ltd. In token of the esteem with which he was held by the members of the operating department he was presented a leather couch.

OBITUARY

DENNIS KILLERLANE

Dennis Killerlane, a retired engineer and boiler maker, head of Killerlane & Ryder, on First St., died on Sunday, May 18, at his home, 983 Bergen St., Brooklyn, in his seventy-sixth year. He was an old member of the Maritime Exchange and was well known in shipping circles. A sister, Miss Mary Killerlane, survives him.

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When the Pennsylvania R.R. intended to change its specifications for boiler plate many years ago, it was stated at the Sixth Congress of International Association for Testing Materials it was the custom, as far back as 31 years ago, that from all worn-out boilers test pieces were taken and retested. Original duplicate testpieces from the new sheets were laid away, and when the worn-out firebox sheets were returned to the testing department the original duplicates were searched for and tested in comparison with the worn-out plate. This practice was carried on for 13 years, and these tests invariably have shown: (1) That, as far as it can be traced, the effect of the heat on the boiler sheet reduced any internal stresses due to the rolling; and (2) that whatever defects are found could almost invariably be traced to mechanical defects in the shop, in bending in flanging, in riveting, in drifting the rivet holes cold, and these effects then made their appearance by and through overstrain.

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The energetic fight being made for new business by the Quebec Railway, Light & Power Co. and the Dorchester Electric Co., of Quebec, is reflected in the reduction of rates made by the former company from 15c. to7c. per kw.-hr. The Dorchester Electric Co. announces its intention of meeting the cut by making its base rate for energy 6c. per kw.-hr.

NEW EQUIPMENT

ATLANTIC COAST STATES

The Milo Electric Light Co. is making preliminary arrangements for the installation of additional equipment in its power plant at Milo, Maine. Julian d'Este, Milo, is purchasing agent.

Arthus W. Dwyer is interested in the installation of an electric system at Paxton, Mass.

The installation of additional equipment in the municipal electric-light plant at East Norwalk, Conn., is under consideration. Fred H. Bergen is superintendent of the plant.

Plans are being prepared by the Cohoes Electric Light Co. for the construction of a power plant on the Mohawk River, near Cohoes, N. Y. Estimated cost, $1,000,000. Bids for the work will be received at the New York office of the company, 2 Rector St.

SOUTHERN STATES

Preliminary arrangements are being made for the reconstruction of the municipal electric-light plant and water system at Orangeburg, S. C. L. H. Wanamaker is city clerk.

Plans are being considered for the installation of additional equipment in the municipal electric-light plant at Statesboro, Ga. D. L. Gould is manager of the plant.

Plans are being considered for the installation of new equipment in the municipal electric-light plant at Waynesboro, Ga. J. C. Andrews is superintendent of the plant.

Plans are being considered by the Leesburg Ice Co., Leesburg, Fla., for the installation of additional equipment in its electric-light plant to double the capacity. J. Y. Clark is president.

The proposition to issue bonds for the construction of a municipal electric-light plant is under consideration by the citizens of Panama City, Fla.

Plans are being prepared by the Vivian Oil Co., Vivian, La., for the construction of an electric-light plant to cost $50,000.

The city council of Monterey, Tenn., has granted a franchise to J. T. Price and associates for the construction of an electric-light plant.

The Kentucky Utilities Co. will install additional equipment in its power plant at Somerset, Ky. T. J. Spragle is general manager.

CENTRAL STATES

At an election to be held soon the proposition to issue $110,000 in bonds for the construction of a municipal electric-light plant at Barberton, Ohio, will be submitted to the voters. W. S. Mitchell is mayor.

Bids will be received by W. J. Springborn, director of public service, Cleveland, Ohio, until May 27, for furnishing generators and converters and electric traveling cranes for the municipal electric-light plant.

B. F. Hewitt, consulting engineer, Jefferson, Ohio, is preparing plans for the construction of a municipal electric-light plant and water system at Cortland, Ohio.

The Consumers' Power Co. is considering plans for the improvement and extension of its system in Cadillac, Mich., and vicinity. W. A. Foote, Jackson, Mich., is president.

Plans are being considered for the purchase of additional equipment for the municipal electric-light plant at Petoskey Mich. J. W. Lovelace is manager of the plant.

The Central Illinois Public Service Co. has purchased the municipal electric-light plant at Girard, Ill. Plans are being considered by the new owners for the improvement of the plant.

WEST OF THE MISSISSIPPI

Mason & Mason have been granted a franchise to construct and operate an electric-light plant at Alton, Iowa.

The construction of a municipal electric-light plant at Russell, Iowa, is under consideration.

The citizens of Argonia, Kan., will soon hold an election to vote on the proposition to issue $25,000 in bonds for the construction of a municipal electric-light plant and water system. Rollins & Westover, Midland Bldg., Kansas City, Mo., are consulting engineers.

The proposition to issue $11,000 in bonds for the construction of a municipal electric-light plant at Howard, Kan., is under consideration.